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Editorial

THE N.V.M.A. CONFERENCE.

THE Annual Conference of the National Veterinary Medical Association is being held this year at Llandudno from September 18th to 22nd. The programme is of a highly attractive nature, and should promote discussion among veterinarians generally, for all interests have been studied in the choice of subjects. It is to be hoped that members of the profession will attend in their numbers, and rally round the President, Lieut.-Colonel P. J. Simpson, D.S.O., T.D., J.P., F.R.C.V.S., who has so ably presided over the last two Congresses, and who obeyed the unanimous wish of the members last year when he accepted the office of President for the past twelve months. We feel that those who do not, or who unfortunately cannot, attend these Conferences, miss much; for, in addition to gleaning knowledge from a discussion of the various papers, we have an opportunity of recording our own experiences, and of meeting our fellow members socially for a day or two. This helps to keep the profession together and foster the good feeling among us more than anything else can do. We wish the Llandudno Conference every success. The programme includes the following papers:

"The Significance of (*a*) Acid-fast Bacilli, (*b*) *Bacillus coli* in Milk."

"Meat Preservation."

"Helminths of Economic Importance in Farm Animals, excluding Poultry."

"Diseases and Accidents Referable to the Hunting Field and to the Turf."

"Fractures and Dislocations in Small Animals."

XUM

" The Relationship of Poultry Diseases to the Practitioner."

" Johne's Disease, including Johne's Disease in Sheep."

" Swine Fever and Enteritis in Young Pigs."

" Vaccination against Bovine Contagious Abortion and the Relationship of this Disease to Undulant Fever of Man."

The Annual Banquet is being held on September 20th, and the Dance in aid of the Veterinary Benevolent Fund on the 21st.

PULPY KIDNEY DISEASE.

We publish in this number an article by Montgomerie and Rowlands on " Pulpy Kidney Disease of Young Lambs in North Wales," and a full abstract of an article on the same subject by D. A. Gill, New Zealand. It is not so long ago since diseases affecting sheep were very imperfectly understood, and that the veterinary profession was seldom, if ever, consulted by sheep breeders. Much of the lack of interest taken by the profession was probably due to their lack of knowledge of the causation of diseases of sheep, and consequently of the treatment to be adopted. Happily, however, as research into diseases of animals has progressed, our knowledge regarding diseases of sheep has improved, till to-day veterinary surgeons who read their veterinary literature must have become acquainted with the results of the various investigations, and are therefore fully aware of the methods to be adopted in the suppression of outbreaks. Sheep farmers, too, are beginning to realise that the veterinary profession has acquired much greater knowledge concerning the maladies of sheep, and are gradually relying more and more on the assistance of their veterinary surgeons in keeping their flocks in a healthy state, and in controlling outbreaks of disease among them. This is exactly as it should be, and the various research workers in this and other countries who have devoted their time and energy to the investigation of these disease problems are to be congratulated on undertaking such work, the results of which enable the veterinary practitioner to enter into yet another sphere of service with full confidence.

Diseases of sheep are essentially conditions for the application of preventive, rather than curative, measures; and a perusal of the various articles referred to will indicate how such conditions yield to proper scientifically-controlled preventive measures. Further, the work on sheep diseases, especially those relating to the entero-toxæmia type, must be brimful of interest to the scientific worker; and in particular those caused by that group of organisms *B. welchii*, at one time thought to be of little importance, but which is now gradually being shown to play a bigger part in the causation of disease than could ever have been anticipated. It will not be at all surprising if the work done on this group as related to diseases

of sheep may open the way to the study of some of the more obscure diseases among other species of the domesticated animals. Records of work such as are published in this number are indicative of the extremely useful part being played by the veterinary research worker to-day.

POULTRY DISEASES.

As we go to press, the Fifth World's Poultry Congress is being held in Rome. The Congress is being attended by poultry keepers and by research workers from countries all over the world. The October number of THE VETERINARY JOURNAL will be devoted to Diseases of Poultry, and will contain an account of the Congress.

XUM

General Articles

PULPY KIDNEY DISEASE OF YOUNG LAMBS IN NORTH WALES.

The Toxicity of Intestinal Contents and the Nature of the Toxic Element.

By R. F. MONTGOMERIE, B.Sc., Ph.D., F.R.C.V.S.,
AND
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In a previous article[7] the disease of young lambs, now commonly known as pulpy kidney disease (hereafter referred to as P.K.), was described as it appears in North Wales. Certain preliminary observations on its nature were recorded. During the spring of 1932 and that of 1933, further investigation was undertaken, and this article covers that section of this work which was devoted to the study of the toxicity of the intestinal contents of lambs dead of this disease, and to the nature of the "toxin" found therein. An account of work along other lines will be published at a later date.

In 1932, some element toxic to laboratory animals on intravenous inoculation was demonstrated in sterile filtrates of the diluted intestinal contents of nine of the eleven cases examined. This toxicity was not neutralised by any of the antisera available to the writers (including *B. welchii* (lamb dysentery) antiserum), but was thermolabile. Gill,[2] working in New Zealand, had obtained similar results in his investigation of an apparently identical disease.

In 1931, Bennetts[1] defined the so-called braxy-like disease of sheep in Western Australia as an infectious entero-toxæmia: "An acute toxæmia of sheep following the rapid multiplication of a specific toxicogenic anaerobic bacterium, *B. ovitoxicus*, within the contents of the small intestine." He demonstrated that the toxicity of the filtrate of intestinal contents obtained from such cases was neutralised by antiserum prepared against the toxin of his *B. ovitoxicus*, and also by *B. welchii* (L.D.) antiserum. *B. welchii* antiserum did not protect.

Oxer (1932)[9], investigating pulpy kidney in lambs in Tasmania, detected a toxin in the filtered contents of the small intestine of the five cases he examined. This toxicity was neutralised by *B. ovitoxicus* antiserum supplied by Bennetts, but not by *B. welchii* or by *B. œdematiens* antisera.

Gill (1932)[3] recorded failure in the one attempt made in 1930, and in others made in 1931, to neutralise the toxicity of filtrates of intestinal contents with *B. welchii* (L.D.) antiserum. Having isolated an ovitoxicus-like organism, he,

however, later stated[4] as one of his grounds for considering that this organism and its toxin are responsible for P.K. in New Zealand, " the toxin in the affected lamb's gut is neutralised if it is mixed with antitoxins prepared from *B. ovitoxicus* (Bennetts), New Zealand pulpy kidney strains and L.D. bacillus, but is not neutralised by *B. welchii* or *B. paludis* antitoxin." In a footnote he explains his previous record, that lamb dysentery antitoxin had not neutralised, by observing that of two batches of this antiserum in his possession one definitely gave no neutralisation, whereas the other did, but not to a very high degree.

Observations during the 1932 Season.

(1) *The Toxicity of Intestinal Filtrates.*—During the spring of 1932, seventeen cases were obtained which on history, post-mortem findings (macroscopic and microscopic) and bacteriological evidence were typical of P.K. The period which had elapsed between death and examination varied greatly—from a few minutes to as long as six hours, but the majority of the cases were examined within two hours. The contents of the small intestines of each were diluted with an equal volume of sterile saline and filtrates obtained through a Sietz Filter fitted with an E.K. special pad. These filtrates regularly proved sterile, and were inoculated intravenously into mice to demonstrate whether a readily detectable toxin was present. The dose of filtrate used for this purpose was 0.4 c.c. (0.2 c.c. intestinal contents). Of these seventeen cases twelve gave filtrates which proved fatal within twenty-four hours. While no attempt was made to define their minimum lethal dose, it may be observed that in six, 0.1 c.c. killed readily; in two, 0.05 c.c. was highly toxic, and in the remainder doses below 0.4 c.c. were not tried. The toxicity of two of the more highly potent filtrates was tested on lambs.

A normal four-weeks-old lamb, weighing 16½ lb., received 5 c.c. of the filtrate from case No. 14 at 12 noon. During the succeeding twenty minutes it appeared dull, but otherwise normal. Very soon thereafter inco-ordination became evident. Abdominal pain was made obvious by alternate lying down and rising. Within thirty-five minutes after injection the lamb appeared to have some disturbance of vision, and failed to regain its feet after it had gone down heavily. Lying on its side, a period of laboured respiration was quickly followed by continued inco-ordinate paddling movements. Muscular tremors developed, and the respirations became gasping in nature. Violent struggling movements were soon in evidence, and the lamb died at 12.50 p.m. in a typical " spasm "—the legs firmly extended and the head drawn back on to the shoulder. Post-mortem examination of this lamb was delayed until one and a-half hours after death. The lesions were typical of naturally occurring P.K. Cultures taken from various sites remained sterile, and a filtrate prepared from the intestinal contents was non-toxic on inoculation into mice. (*See* Figs. 1, 2 and 3.)

A similar lamb received 5 c.c. of the intestinal filtrate from case No. 6 at 12.15 p.m. A distinct and increasing dullness was evident during the following half

hour. Thereafter the rate of respiration distinctly increased, and breathing became laboured. Difficulty of vision appeared and a general weakness, together with muscular tremors, became evident. One hour after injection it had the appearance of being asleep on its feet, and was showing marked salivation and a constant slow swaying from side to side. The general weakness becoming more obvious, the lamb collapsed and, struggling in an aimless fashion, made occasional attempts to rise. Much frothing at the mouth was seen, and quiet periods alternated with severe convulsive movements. Within two and a-quarter hours the lamb died in a particularly severe " spasm " quite typical of that seen at the termination of a case of natural P.K. On post-mortem examination fifteen minutes after death, the general appearances of a lamb dead of a natural P.K. were evident. Cultures from various body fluids and organs remained sterile, and a filtrate of the intestinal contents was atoxic on inoculation into mice. (*See* Figs. 4, 5 and 6.)

As controls to these observations opportunity was taken to examine for toxicity similar filtrates from six lambs dead of lamb dysentery, and from three lambs dead of causes other than P.K. or L.D. In each of the L.D. cases the intestinal filtrate was highly toxic : doses as low as 0.025 c.c. (0.0125 c.c. of intestinal contents) killing within ten minutes. It was noticed that whereas the filtrates from the P.K. cases retained their original potency for at least some time, those from L.D. cases showed an early and distinct fall in toxicity. Of the other three lambs, the cause of death in one was not obvious, in one there was obstruction by a wool-ball at the pylorus, and the third was a case of vegetative endocarditis. Filtrates from these cases proved atoxic to mice in the test dose (0.4 c.c.).

(2) *The Nature of the Toxic Element.*—The observation that heating at 60° C. for half an hour rendered toxic filtrates from P.K. cases atoxic was confirmed, for each of the twelve toxic filtrates mentioned above was thermolabile. The effect of formalin had been noted in the previous year, but was not recorded. It was again shown that incubation for three days in the presence of 0.3 per cent. formalin altered the " toxin." Apparently it did not render it completely innocuous, for where sufficient material was available the intravenous inoculation of double the known lethal dose of filtrate was still toxic to mice. The toxin in the filtrates from the six L.D. cases was similarly thermolabile, and apparently rendered completely innocuous by the addition of formalin.

For neutralisation observations fresh batches of various high titre antisera were kindly supplied by the Wellcome Physiological Research Laboratories. Eight of the twelve toxic filtrates mentioned above, those of highest toxicity, were tested with these antisera, as were the six filtrates from the L.D. cases. Known toxic doses of each filtrate were mixed with an equal volume of each of the various antisera, and after incubation for half an hour at 37° C. these mixtures were inoculated intravenously into mice. These experiments are summarised in Table No. I, from which it will be seen that only *B. welchii* (L.D.) antiserum appeared capable of influencing the toxicity of the P.K. filtrates. This serum

XUM

in no case gave complete neutralisation, but it reguiarly delayed death, in some cases to a striking extent. The toxicity of each of the L.D. filtrates was completely neutralised by *B. welchii* (L.D.) antiserum, and by *B. paludis* antiserum, but not by any other.

TABLE No. I.

THE PROTECTION AFFORDED BY VARIOUS ANTISERA AGAINST THE TOXICITY OF INTESTINAL FILTRATES. OBSERVATIONS DURING THE 1932 SEASON.

	Case No.	Toxic dose of filtrate	Toxic dose of filtrate, plus an equal amount of antiserum prepared against: *B. welchii*	*B. welchii* (L.D.)	*B. paludis*	*B. œdematiens*	*V. septique*
P.K. cases	2	0.1 c.c. †2	†2½	†15	—	†2	†2½
	4	0.1 c.c. †3	†3½	†36	—	†4	†3
	6	0.1 c.c. †2	†3	†15	—	†2½	†2½
	13	0.1 c.c. †2½	†3	†8	†2	†2½	†3
	14	0.05 c.c. †3	†4	†7½	†2½	†4	†3½
	15	0.05 c.c. †1	†1½	†3	†1½	†1	†1½
	16	0.1 c.c. †6	†6	†24	†7	†6½	†6
	17	0.1 c.c. †1	†2	†3	†2	†1½	†2
L.D. cases	1	0.05 c.c. †	†	L	L	†	†
	2	0.05 c.c. †	†	L	L	†	†
	3	0.05 c.c. †	†	L	L	†	†
	4	0.05 c.c. †	†	L	L	†	†
	5	0.05 c.c. †	†	L	L	†	†
	6	0.1 c.c. †	†	L	L	†	†

†=Died (figures=interval in hours between inoculation and death, which in the L.D. cases was less than ½). L=lived.

Summary of 1933 Observations.

(1) In twelve of seventeen cases of P.K. a sterile filtrate of diluted small intestinal contents proved toxic to mice on intravenous inoculation in doses ranging from 0.05 c.c. to 0.4 c.c. (0.025 c.c. to 0.2 c.c. intestinal contents). (2) Symptoms: Death and post-mortem appearances identical with those seen in naturally occurring P.K. were reproduced in two young lambs by the intravenous inoculation of 5 c.c. of two of these toxic filtrates. (3) The toxic element in each of the twelve filtrates was thermolabile, and the toxic dose rendered innocuous by formalin. Observations on its neutralisation were made with the eight most toxic filtrates. It was not neutralised by antisera prepared against *B. welchii*, *B. paludis*, *B. œdematiens* and *Vibrion septique*. *B. welchii* (L.D.) antiserum did, however, appear to neutralise to some extent. (4) Filtrates of the diluted intestinal contents of six lambs dead of L.D. contained a highly potent toxin which was thermolabile, rendered innocuous by formalinisation, and was completely neutralised by *B. welchii* (L.D.) antiserum and by *B. paludis* antiserum, but not by any of the other antisera mentioned above. (5) A toxic element was not detected in the filtrates of intestinal contents of three lambs dead of other diseases or of the two lambs dead following inoculation with toxic P.K. filtrates.

XUM

Observations During the 1933 Season.

The detailed account of Bennetts' work on " Infectious Enterotoxæmia of Sheep in Western Australia," Oxer's observations on " Pulpy Kidney in Lambs," and Gill's later findings, reached the writers after the close of the 1932 season in North Wales. Since both Oxer and Gill concluded that the toxin in the intestinal contents is that of *B. ovitoxicus*, Bennetts' observations on the relationship of that organism to other members of the *B. welchii* group assumed particular significance in this work. He found that *B. welchii* (L.D.) antiserum (prepared at the Wellcome Laboratories in 1929) gave complete protection against *B. ovitoxicus* toxin, as found in the intestinal filtrates and as produced *in vitro*. Even bearing in mind the somewhat inconsistent results which Gill had obtained with L.D. antiserum, the failure of this antiserum to give complete neutralisation in the writers' earlier observations made it impossible to accept as probable that the toxic element present in intestinal filtrates in cases of P.K. in North Wales was that of *B. ovitoxicus*. It was therefore decided to continue the observations on the toxicity of intestinal contents, and on the neutralisation of toxic filtrates, and to extend them by accepting for investigation all cases of P.K., even if dead several hours.

(1) *The Toxicity of Intestinal Filtrates.*—During the 1933 season forty-two cases of typical P.K. were obtained. Some were received alive, some immediately after death, but the majority had been dead two to five hours, and a few even more than twenty-four hours. Filtrates were prepared from diluted intestinal contents and examined for toxicity by intravenous inoculation into mice, as in the previous year. In the filtrate from twenty-seven of these forty-two cases a toxic element was evident, 0.4 c.c. being toxic to mice in six, and 0.2 c.c. or less in the remainder. Of the fifteen filtrates in which " toxin " was not detected, five were from " chronic " cases, the lambs having lived for more than twenty-four hours after the appearance of P.K. symptoms. Such cases were much more commonly encountered during the past season than in previous years.

In seven cases an attempt was made to determine the site of toxin production. The contents of the duodenum, jejunum and ileum were collected separately, and separate filtrates prepared. In view of the very small amount of material available from the ileum, it was necessary to dilute its contents with twice their volume of saline. Otherwise the preparation and testing of these fractions was as in the case of mixed intestinal contents. In no case did 0.4 c.c. of the filtrate of duodenal contents prove toxic, and in three cases the preparation from the contents of the jejunum was similarly non-toxic. In each case the ileum preparation was highly toxic. It would, therefore, seem that the site at which the toxin is present in greatest abundance is the last few feet of the small intestine. At the height of the P.K. season an apparently normal forward lamb was obtained from a farm on which these losses are experienced every year. This lamb was killed by chloroform inhalation, and allowed to remain on the post-mortem table. Six hours after death the contents of the small intestine were removed,

XUM

FIG. I.

FIG. II.

FIG. III.

FIG. IV.

FIG. V.

FIG. VI.

"Pulpy Kidney Disease" of Young Lambs in North Wales.

(*Article by* R. F. Montgomerie, B.Sc., Ph.D., F.R.C.V.S., and W. T. Rowlands, M.R.C.V.S., D.V.S.M., *page* 388)

XUM

XUM

and a sterile filtrate prepared in the usual manner. This filtrate was atoxic to mice in the test dose (0.4 c.c.).

(2) *The Nature of the Toxic Element.*—In view of the results obtained in the previous year, it was decided to concentrate on observations with antisera prepared against members of the *B. welchii* group. The Wellcome Laboratories placed at the writer's disposal a generous supply of *B. welchii*, *B. welchii* (L.D.) and *B. paludis* antiserum, and later a supply of antiserum made at these laboratories from a culture of the D type of *B. welchii* isolated by Wilsdon.[9] Contact had been established with Bennetts in Western Australia and with Oxer in Tasmania, and each of these workers very kindly sent a small supply of *B. ovitoxicus* antiserum; Oxer advising that the serum he sent was of rather low potency. In addition, McEwen had favoured the writers with a supply of *B. paludis* antiserum which he had prepared at Wye.

TABLE No. II.

THE PROTECTION AFFORDED BY VARIOUS ANTISERA AGAINST THE TOXICITY OF INTESTINAL FILTRATES. OBSERVATIONS DURING THE 1933 SEASON.

Case No.	Toxic dose of Filtrate	Toxic dose of filtrate, plus an equal amount of antiserum prepared against: *B. welchii*	*B. welchii* (L.D.) (C1971A)	*B. welchii* (L.D.) (C1852)	*B. welchii* (L.D.) (Q232)	*B. paludis*	*B. ovitoxicus* (Bennetts)	*B. ovitoxicus* (Oxer)	*B. welchii* (Wilsdon type D)
1	0.4 c.c.	†7½	†8	†8	†7½	L	†8	L	L	L
3	0.2 c.c.	†4½	†5	†4½	†5	L	†5½	L	L	L
4	0.1 c.c.	†1	†1½	†1½	†1	L	†1½	L	†6	L
5	0.2 c.c.	†1	†1	†1½	†1½	L	†2	L	†7	L
6	0.2 c.c.	†3	†3½	†2½	†3	L	†3½	L	†12	L
7	0.2 c.c.	†¼	†¼	†¼	†¼	L	†¼	L	L	L
9	0.2 c.c.	†1	†1¼	†2	†1½	L	†2	L	L	L
10	0.2 c.c.	†1½	†1½	†2	†1½	L	†2	L	L	L
11	0.4 c.c.	†3	†3	†3½	†3	L	†3	L	L	L
12	0.2 c.c.	†2½	†3	†3	†2½	L	†2½	L	L	L
13	0.2 c.c.	†3	†3¼	†3½	†3	L	†3½	L	L	L
14	0.2 c.c.	†1¼	†1½	†1	†1½	L	†2	L	†10	L
15	0.2 c.c.	†1¼	†1¼	†1	†1½	L	†1½	L	L	L
16	0.2 c.c.	†4	†3½	†4	†3½	L	†4	L	L	L
17J	0.4 c.c.	†4½	†4½	†4	—	—	—	—	—	L
17I	0.1 c.c.	†8	†7½	†7½	—	—	—	—	—	L
19J	0.4 c.c.	†4	†4½	†4	—	—	—	—	—	L
19I	0.05 c.c.	†¼	†¼	†¼	—	—	—	—	—	L
20J	0.2 c.c.	†2½	†2	†2¼	—	—	—	—	—	L
20I	0.1 c.c.	†½	†1	†1	—	—	—	—	—	L
21I	0.05 c.c.	†11	†11½	†11	—	—	—	—	—	L
18I	0.4 c.c.	†3	†3	†3½	—	—	—	—	—	L
28I	0.05 c.c.	†1½	†1½	†1¼	—	—	—	—	—	L
29J	0.4 c.c.	†2	†2½	†2¼	—	—	—	—	—	L
29I	0.2 c.c.	†2	†2	†2¼	—	—	—	—	—	L
32	0.2 c.c.	†2	†2½	†2	—	—	—	—	—	L
33	0.2 c.c.	†¼	†¼	†¼	—	—	—	—	—	L
35	0.4 c.c.	†8	†8	†7	—	—	—	—	—	L
36	0.2 c.c.	†2½	†2	†2	—	—	—	—	—	L
37	0.4 c.c.	†1½	†1½	†2	—	—	—	—	—	L
38	0.1 c.c.	†2	†2½	†2	—	—	—	—	—	L

†= Died (figures=interval in hours between inoculation and death).
L=lived. J=jejunum filtrate. I=ileus filtrate.

XUM

In view of some particularly interesting observations made almost at the outset, the writers brought into use two batches of L.D. antiserum they had had stored in their refrigerator for some time. None of the L.D. serum used in 1932 remained, but a small supply of another batch, and an unopened bottle of L.D. serum issued through Burroughs Wellcome & Co. in 1929 for prophylaxis in the field, were available. The writers, therefore, had for use in this work the following antisera: (1) *B. welchii* antiserum, GG 2748A, Wellcome Physiological Research Laboratories. (2) *B. welchii* (L.D.) antiserum, Q 232, issued by Burroughs Wellcome & Co. for field prophylaxis in 1929. (3) *B. welchii* (L.D.) antiserum, C 1852, W.P.R.L., prepared in 1932. (4) *B. welchii* (L.D.) antiserum C 1971A, W.P.R.L., prepared in 1932. (5) *B. paludis* antiserum, W.P.R.L. (6) *B. paludis* antiserum, McEwen. (7) *B. ovitoxicus* antiserum, No. 3, Bennetts. (8) *B. ovitoxicus* antiserum, P.K. No. 8, Oxer. (9) *B. welchii* (Wilsdon, Type D), W.P.R.L., prepared in 1933.

As the work progressed it became obvious that no material advantage was to be gained by putting up each of the filtrates with all these antisera, and only those necessary for confirmation of the earlier observations were included. The filtrates from each of the first fourteen toxic cases were tested out with each available antiserum; those from the remainder with the three antisera which would define the nature of the toxin (serum prepared against *B. welchii*, Wilsdon, type D, being employed rather than Bennetts' ovitoxicus serum, because the supply of the latter was limited). This work is summarised in Table No. II, in which for convenience the observations with the two batches of *B. paludis* antiserum are shown as one, the results with each being identical.

It will be seen from the table that, as in previous years, *B. welchii* antiserum afforded no protection. The L.D. sera C 1971A and C 1852 failed to neutralise, but Q 232, the L.D. serum issued in 1929 for field prophylaxis, afforded *complete* protection. These results were so contradictory that some error was suspected. It was found, however, that this Q 232 serum, like C 1971A and C 1852, afforded complete protection against the toxin produced *in vitro* by a culture of *B. welchii* (L.D.) isolated by Dalling. Furthermore, Dalling was good enough to confirm these results, thus showing that the sera were correctly labelled, and establishing as a fact that a variation of fundamental importance can, and does, occur between batches of L.D. serum. Neither of the two batches of *B. paludis* antiserum afforded the slightest protection, whereas the *B. ovitoxicus* serum prepared by Bennetts regularly neutralised the toxic element of these filtrates. The ovitoxicus serum which Oxer sent was known to be of low potency, and this may explain its occasional failure to give full protection in some instances. The antiserum prepared against a strain of *B. welchii* (Wilsdon, type D) behaved as did Bennetts' ovitoxicus serum, protecting throughout.

Summary of the 1933 Observations.

(1) In twenty of thirty-five cases of P.K. the sterile filtrate of diluted small intestinal contents proved toxic to mice in doses ranging from 0.1 c.c. to 0.4 c.c.

XUM

In seven other cases in which the contents of the various portions of the intestine were separately tested, toxicity was demonstrated in the ileum contents in all, in the jejunal contents in four, but in none of the duodenal contents. (2) The mixed small intestinal contents of a normal lamb, taken six hours after death by chloroform inhalation, did not contain detectable toxin. (3) The toxic element in the filtrates was not neutralised by antisera prepared against *B. welchii*, *B. paludis*, nor by two batches of *B. welchii* (L.D.) antiserum. It was, however, completely neutralised by a third batch of *B. welchii* (L.D.) antiserum, by *B. ovitoxicus* antiserum prepared by Bennetts, and by serum prepared at the Wellcome Laboratories against *B. welchii* (Wilsdon, Type D). A rather low titre serum prepared by Oxer against a strain of *B. ovitoxicus* isolated from a P.K. case did not afford full protection in all cases.

General Discussion.

The demonstration of a highly toxic element in the contents of the small intestine of 66 per cent. of the fifty-nine cases diagnosed as P.K. in North Wales during the 1932 and 1933 seasons appears to define this condition as an entero-toxæmia. Gill also could only demonstrate toxicity in a proportion of his cases, although Oxer found the contents of the small intestine toxic in each of the five cases he examined. It cannot be assumed that the toxic element was absent in the remaining 33 per cent. of the writer's cases, since it is very possible that it was present in concentration too low to allow of its detection by the methods adopted. In this connection it is of special interest to note that, judged by the writer's usual standard, the filtrates from the five " chronic " cases encountered during the 1933 season were atoxic. Each of these cases had continued to show typical symptoms for at least twenty-four hours before the lamb was killed for post-mortem examination. Survival for such an exceptionally long period would be consistent with a low-grade, or a fleeting, production of toxin. The opportunity to search for toxin in the small intestinal contents of normal lambs or of lambs dead of other conditions has been limited. While toxin was readily detected in the intestinal filtrates from cases of L.D., it could not be detected in those from three lambs dead of other conditions, from two lambs killed by the intravenous inoculation of toxic filtrates, nor in that from a normal lamb examined six hours after death following chloroform inhalation.

Oxer and Gill have shown that the toxic element in the intestinal contents of lambs dead of P.K. in Tasmania and New Zealand is of bacterial origin, the toxin of *B. ovitoxicus*. On the evidence available there is ample reason for believing that the writers are dealing with a disease of similar nature. It can now be maintained that P.K. of young lambs in North Wales is an infectious entero-toxæmia following the rapid production of toxin in the latter part of the small intestine by a bacterium of the *B. welchii* group. Its exact definition must, however, await the isolation of several strains of the organism which produces this toxin, and its identification, particularly by extensive cross immunity tests, with other members of the *B. welchii* group of bacteria. This branch of the writers'

DEC 2 1933 MANHATTAN KANSAS

XUM

investigation is now at an advanced stage, but on the evidence obtained from the study of intestinal filtrates it would appear that the toxin is that of an organism at least closely related to *B. ovitoxicus* and to *B. welchii* (Wilsdon, type D), which organisms may be identical.

The observations with serum prepared against the toxin of *B. welchii* (L.D.) are of fundamental significance, since they show that such serum may vary greatly in its antitoxic value against the type of toxin produced by *B. ovitoxicus*. It would certainly seem that at least most of the batches of L.D. serum prepared at the Wellcome Laboratories prior to 1930 have regularly contained antitoxin capable of completely neutralising the toxin of *B. ovitoxicus*, whereas those of more recent preparation have contained little or none. (It appears certain that the L.D. antiserum Bennetts worked with was of the type which contains antitoxin capable of neutralising the toxin of *B. ovitoxicus*, and this would explain the writers' earlier difficulty in accepting as probable that the toxicity of their P.K. filtrates was due to toxin production by *B. ovitoxicus* in the intestinal canal). It has been demonstrated[8] that this variation has occurred while the value of the serum in terms of the toxin produced *in vitro* by an accepted strain of the L.D. bacillus has remained consistently very high. The factors which produce these variations are now under investigation at the Wellcome Laboratories, and will be touched on in a paper in preparation by the writers on their more recent work on L.D. in North Wales. It may, however, be said here that the toxin produced by strains of *B. welchii* (L.D.) recently isolated in North Wales does contain a fraction of the ovitoxicus type, whereas subcultures of the original strain isolated at the Wellcome Laboratories and kindly supplied by Dalling, appear to produce, in the writers' hands, no fraction of this type. Herein may lie the reason for the difference in the various batches of serum.

It is of more than passing interest to observe that whereas the inoculation of lambs with L.D. serum within twelve hours of birth had been observed almost entirely to eliminate loss from P.K. in the four seasons up to 1933, this immunity was not afforded—at least on some of the lamb dysentery farms—in that year. Farmers who had previously expressed their faith in these inoculations as a means of preventing P.K. losses, this season complained that deaths from this disease were common. It is known that the L.D. serum issued for field prophylaxis in 1933 did not contain antitoxin capable of neutralising toxin of the ovitoxicus type.

These observations have an added significance when the relationship between *B. welchii* (L.D.) and *B. paludis* come under consideration. While certain cultural differences between these two organisms have been shown to exist, Mason, Ross and Dalling[5] concluded that their toxins were the same. Furthermore, Mason,[6] after a most painstaking study, concluded: "Serologically the chief fraction of the toxins of the 'lamb dysentery bacillus' and *B. paludis* (both original and single-cell cultures) is identical" (the lesser fraction being that common to the toxins of these organisms and to that of *B. welchii*). Mason was working with a subculture of the original "lamb dysentery bacillus" isolated by Dalling in 1923.

XUM

These workers reached their conclusion on the basis of the results of cross-neutralisation tests between the toxins and antitoxins of *B. welchii* (L.D.), *B. paludis* and *B. welchii*. But Bennetts has shown that the L.D. serum he had received from the Wellcome Laboratories (1929) and the *B. paludis* antiserum supplied to him by McEwen behaved very differently when mixed with *B. ovitoxicus* toxin: the former neutralised, whereas the latter failed. In the writers' work they have never observed *B. paludis* antiserum influence the toxicity of intestinal filtrates from P.K. cases, whereas it did neutralise filtrates from certain cases of true L.D. in which every batch of *B. welchii* (L.D.) serum also neutralised. It may be suggested, then, that the outstanding difference between *B. welchii* (L.D.) and *B. paludis* is that, under natural conditions, and probably also when freshly isolated, the former produces an additional toxic fraction of the ovitoxicus type, whereas the latter does not.

The writers' observations leading to this contention are closely analogous to those of Wilsdon[10] in his classification of *B. welchii*. It is noteworthy that with two exceptions the eleven strains which fell into his type B were isolated from "the intestinal contents and ulcers of cases of lamb dysentery disease," and that the only strain of his type C was *B. paludis*. Apart from the fraction common to the toxins of all his *B. welchii*, the toxin of type B contained in addition to a fraction common to it and type C, but absent from type D, a further fraction common to it and type D, but absent from the toxin of type C. His lamb dysentery organisms did, therefore, contain a fraction absent in the toxin of *B. paludis*, which fraction, from the writers' observations, is at least very similar to the chief fraction of the toxin of *B. ovitoxicus*.

General Summary.

(1) The sterile filtrate of diluted small intestinal contents of thirty-nine of the fifty-nine cases diagnosed in North Wales as pulpy kidney disease in 1932 and 1933 proved toxic to mice on intravenous inoculation in doses ranging from 0.05 to 0.4 c.c. (0.025 to 0.2 c.c. intestinal contents). (2) Symptoms, death and post-mortem appearances identical with those seen in naturally occurring cases of pulpy kidney disease were reproduced in two young lambs by the intravenous inoculation of two of these toxic filtrates. (3) Similar filtrates from six cases of lamb dysentery proved toxic to mice on intravenous inoculation in doses as low as 0.025 c.c. (0.0125 c.c. of intestinal contents). The toxic element was less stable than that of the filtrates from pulpy kidney cases. (4) Similar filtrates from three lambs dead of other diseases, from the two lambs dead following inoculation with toxic pulpy kidney filtrates, and from a normal lamb killed by chloroform inhalation, were non-toxic to mice on intravenous inoculation of the test dose (0.4 c.c.–0.2 c.c. of intestinal contents). (5) In seven of the pulpy kidney cases filtrates were separately prepared from the contents of the three portions of the small intestine. In all cases the filtrate from the duodenal contents, and in three cases that from the jejunal contents, was atoxic. The filtrate from jejunal con-

XUM

tents in four cases, and from the ileum contents in all cases, was toxic. (6) The toxic element in each of twelve of the pulpy kidney filtrates and in the six lamb dysentery filtrates proved thermolabile (60° C. for half an hour), and the test dose of each was rendered innocuous by incubation at 37° C. with 0.3 per cent. formalin for three days, although it appeared that at least some of the pulpy kidney filtrates were not completely detoxicated by this treatment. (7) Observations showed that the toxic element in the filtrates from pulpy kidney cases was not neutralised by the following antisera : *B. œdematiens*, *Vibrion septique*, *B. welchii* and *B. paludis*. It was, however, completely neutralised by *B. ovitoxicus* antiserum, and by an antiserum prepared against *B. welchii* (Wilsdon, type D). Lamb dysentery antiserum gave inconsistent results ; two batches giving no neutralisation, one batch partial, and a fourth batch complete neutralisation, despite the ability of each to completely neutralise the toxin produced *in vitro* by a long isolated, well-recognised strain of *B. welchii* (lamb dysentery). (8) The toxic element in the six filtrates from lamb dysentery cases was completely neutralised by *B. paludis* antiserum, and by the only batch of lamb dysentery serum used —that which gave only partial neutralisation with pulpy kidney filtrates.

Acknowledgment.—The writers' thanks are due to : (1) The veterinary practitioners and flockowners in the Province, through whom material for investigation was made available. (2) Dr. Bennetts, Mr. McEwen and Mr. Oxer for a supply of antiserum. (3) Dr. O'Brien and Mr. Dalling of the Wellcome Physiological Research Laboratories for their very generous assistance in making an ample supply of various antisera available throughout these investigations.

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References to Figures (*facing page* 392).

Figs. 1, 2 and 3.—Lamb inoculated 5 c.c. intestinal filtrate from Case 14 (1932).
Fig. 1.—Photograph taken 35 minutes after inoculation.
Fig. 2.—Photograph taken 40 minutes after inoculation.
Fig. 3.—Photograph taken 45 minutes after inoculation (on the point of death).
Figs. 4, 5 and 6.—Lamb inoculated 5 c.c. intestinal filtrated from Case 6 (1932).
Fig. 4.—Photograph taken 30 minutes after inoculation.
Fig. 5.—Photograph taken 50 minutes after inoculation.
Fig. 6.—Photograph taken 1¼ hours after inoculation.

XUM

REPORT ON PULPY KIDNEY DISEASE OF LAMBS: AN ACUTE ENTEROTOXÆMIA OF BACTERIAL ORIGIN.*

By DUDLEY A. GILL, M.R.C.V.S., D.V.S.M.

THIS Report is a record of the work done and observations made by Gill on the disease known as "pulpy kidney" in New Zealand. The Report opens with a Foreword by C. J. Reakes, D.V.Sc., M.R.C.V.S., who explains how the losses from this disease, though formerly not sufficiently great to be of financial importance to individual farmers, and looked upon as an indication that the lambs were thriving well, commenced to increase, and representations were made to have a thorough investigation made. Gill began his observations in 1926, and by 1928 he had concluded that "the absorption of bacterial toxins from the intestine would ultimately prove to be the actual cause of the disease." In 1930, definite evidence was forthcoming, and in 1931 the responsible organism was isolated. The identity of the organism was established in 1932, and "the necessary work carried out to incriminate it as the immediate cause of death." Dr. Reakes is of opinion that Gill's work will result in "a means by which severe outbreaks among valuable lambs may be promptly checked."

The Report itself comprises an Introduction (pp. 1–3); Part I, General and Epidemiological Observations on the Disease (pp. 3–29); Part II, the Ætiology of Pulpy Kidney Disease (pp. 30–49); and an Addendum: Relationship of *B. ovitoxicus* (N.Z.) to Wilsdon's *B. welchii* (type D) (pp. 49–52). The following is a fairly full abstract of the Report:

Introduction.

The author draws attention to the fact that some of the work included may appear to be irrelevant, especially that on the biochemical side, but he hopes that it may prove of value in the study of other sheep diseases. He realised early that the disease was intestinal in origin, and that although the causative organism must be very widespread on the pastures of the affected areas, the incidence of the disease was low; something must occur in the intestine of affected lambs, *e.g.*, an attack of indigestion or some change in *p*H, etc., which allows the causative organism to "function as a pathogen." He adds: "It is well within the bounds of possibility that other pathological conditions whose exact ætiology is unknown, but which at present are attributed to some nutritional disturbance, may be of a similar nature."

An account of earlier work in New Zealand on the disease is given, and papers by Gilruth published in 1895, 1899 and 1907 are quoted; from these it appears that the disease has been known in New Zealand for many years. The present investigation was commenced because of an apparent increase in the number of cases, especially in Otago, where 5–10 per cent. of the best lambs, two to six weeks

* Abstract of Research Report issued by the New Zealand Department of Agriculture.

XUM

old, were being lost on many farms. Gill attributes the increase to the marked increase in the use of Romneys—a breed which thrives and fattens extremely well—and to the destruction of rabbits, with the consequent increase in the feed available for the sheep.

Part I.

Symptoms.—Most lambs are found dead. Affected lambs appeared " apparently healthy up to a moment when convulsions suddenly occurred, and they then either died instantly or within a few minutes." Figures show that 10 per cent. of affected lambs were found alive, and of these, 70 per cent. showed the hyperacute or convulsive type of disease, 20 per cent. the acute or head retraction type, and 10 per cent. the subacute or lethargic type. In the *hyperacute* type the lamb suddenly becomes convulsed and dies within a few minutes, or it may live for an hour, when it shows intermittent convulsions, between which it lies with widely dilated pupils and shows jerky breathing. Handling seems to cause intense pain. Straining may occur with the passage of greenish, pultaceous excreta containing much mucus. A lamb affected with the *acute* type presents similar symptoms, though less violent in character. Such lambs also show fairly rigid extention of the limbs with a forcing back of the head till the poll almost rests on the withers. It is rare to find convulsions; affected lambs may live for some days, but rarely recover. In the *subacute* type the lamb is dull, and wanders carelessly in a circle with its head and ears drooping. The eyes are found to be amaurotic. As a rule the lamb continues to wander round, and eventually recovers if purged and kept without food or drink for forty-eight to sixty hours, and is then given small feeds at short intervals. Some cases, however, develop acute symptoms and die. It is interesting to note that toxin in demonstrable quantities has been found in the hyperacute cases only. The writer's view regarding these three types is that the hyperacute convulsive type is the true pulpy kidney syndrome, and that the others are probably the outcome of acute digestive disturbances, uncomplicated by the presence in the gut of the specific organism.

Post-mortem.—In the lambs found dead, or killed while in the hyperacute stage, there is an intense passive congestion of the abdominal organs, especially the liver and kidneys. There is also some congestion of the lungs and fluid in the pericardium, with petechiæ under the epicardium and diffuse hæmorrhagic markings under the endocardium. The thoracic part of the thymus is congested and shows petechiæ. The above are the constant lesions. There may also be found (1) " pulpiness " of the kidneys, in which the cortex is deep-red and semi-fluid; (2) diffuse, deeply congested areas in the cortex of one or both kidneys, producing a mottled appearance on the surface; (3) intense uniform congestion of the renal cortex on both sides without any pulpiness; (4) irregular ecchymosis under the peritoneal surface of the small intestine; (5) some infiltration of clear serous fluid between the layers of the mesentery, where it is deflected over the ileum. The stomach contents depend on the age of the lambs, but there is usually present a considerable quantity of soil and wool. The intestine is not

XUM

inflamed, though there may be some catarrh. The contents of the colon and rectum are pultaceous, gassy and mucus-coated. There may be some evidence of cerebral hyperæmia and congestion of the meninges, but there is no excess of cerebro-spinal fluid. In the *acute* type the outstanding and constant lesion is a diffuse hæmorrhage into the substance of the thalamus or adjacent parts of the brain, often more marked on one side. Heart lesions as above, but in a minor degree, are present. The kidneys are generally moderately congested. The *subacute* case shows a marked difference. There is no congestion or hæmorrhages in the organs. The liver is yellowish and fatty, and there may be excess of cerebro-spinal fluid, but no hæmorrhages. The stomach contains a variety of débris. The contents of the colon are firm.

Histology.—The *kidneys* in the pulpy stage consist of a mass of blood and disintegrated tubules, etc., in the cortex. There is no nuclear staining except in some cells in the glomeruli. The medulla shows infiltration of blood cells between the tubules with degenerative changes in the tubules. (The author feels that the cortex changes occur after death.) When the kidney is not pulpy the cortex shows congestion, and many hæmorrhages are found throughout the cortex. There are fairly general degenerative changes in the epithelial cells of the proximal convoluted tubules. The cells are swollen, and the glomeruli are congested. If the kidney be preserved for section at once after death in the hyperacute type, the only abnormal condition is its engorgement with blood. (There are some differences in the histological picture described by Gill and that by Bosworth and Glover, working on apparently the same disease in this country.)

The liver varies from being markedly congested in the hyperacute type, with the liver cells normal except for vacuolation, to absence of congestion, and the presence of fat droplets in the cells in the subacute type ; the latter may be due to the results of the lambs having eaten nothing for some days before death. The heart appears normal except for evidence of subepi- or subendo-cardial hæmorrhage. The lungs are normal except for evidence of passive congestion in the acute and hyperacute type. The brain shows no change in the subacute type. In the acute type there is congestion of the meninges, and in the hyperacute cases there is hæmorrhage in the basal part of the cerebrum. The small intestine, though prepared in various ways and under various conditions, has usually been found normal.

Epidemiology.—The age of affected lambs is from ten days to eight weeks, but mostly two to four weeks. In some seasons three-months-old lambs have been affected. Lambs from Romney, Merino, Corriedale, Border Leicester, Southdown sheep are all mostly affected, in fact lambs from any sheep running on the rich pastures. Lambing earlier or later did not seem to have any effect on the incidence. In most seasons the losses occur in the latter part of October or early November, but in some years a further period of loss occurs when lambs are about three months old, especially when there has been good growth of grass in January and February, following a fairly dry midsummer. Under such conditions,

XUM

weaning of lambs seems to check the losses. The average loss is about 4 per cent., though a loss of 12.5 per cent. on one farm is recorded. There seems to be heavy losses among twin lambs. (Ewes nursing twins are run on the best feed.) Generally speaking it is the " best " lambs that become affected, though cases among moderately conditioned and even poor lambs may also be found.

The Report now deals with the types of pasture on which losses occur, and with botanical analyses. It appears that the losses occur on widely different classes of pasture, but are found more prevalent on farms where the pasture provides a diet with a nutritional ratio of about 1 : 6, which is very suitable for high production of milk. There was no significant difference in the incidence of the disease on soils where chemical analysis was completely different.

Several pages are devoted to the effect on the death-rate of the way the ewes are wintered, and while there is some evidence that the way the ewes are wintered has an important bearing on the rate of loss, the author adds " that the sole explanation of the predisposing factors is not to be found in the large quantity of milk given by the ewes under favourable conditions is apparent from various, certainly unusual, incidents which have been met with. Not only may the disease sometimes occur in a lamb that is by no means in a good or thriving condition, but occasionally a heavy loss is encountered in flocks where the ewes have been badly wintered, and are in very low condition at lambing. In one such case, which was personally investigated, the ewes were practically starved in the winter, and some were lost from sheer inanition ; yet there was a heavier loss from pulpy kidney in the lambs that season than has been experienced either before or since." The analyses of samples of milk from ewes are fully detailed, and the conclusion is reached that " while the figures require confirmation in a more normal season, they suggest rather strongly that ewes whose lambs die of this disease are giving more and richer milk than are the ewes with normal lambs in the same locality." There is no direct evidence that the same ewe will lose her lambs year after year, nor that after a lamb dies a " twinned " lamb will also die.

Preventive Measures.

Marking Operation.—Gilruth recommended this. Gill has observed that in some cases the actual operation seems to have increased the incidence of the disease. Overstocking the paddocks was tried because of the apparent association between an abundant milk supply and the incidence of the disease. This has proved non-effective, and resulted in some cases in a heavier death-rate, probably due to the fact that the disease is infectious, and the overcrowding tended to create more infection. Salt licks of various types were ineffective. The use of green oats seems to have been followed by encouraging results, but it is pointed out that " in most instances it is impracticable to have sufficient paddock space given over to green oats at this time of year." Controlled exercise as a preventive was tried, and even though it could not be done consistently nor thoroughly, there is evidence that a saving in the losses was effected following its adoption. " Yard-

XUM

ing," *i.e.*, the driving of the ewes and their lambs into fenced-in yards and keeping them there for twenty-four hours every four to seven days, " is the best means we have as yet of ' prevention by management.' It is said to be effective by all farmers who have tried it conscientiously. Moreover, it does not set the ewes and lambs back to any noticeable degree as might at first sight be expected. It is recommended to begin it when the lambs are ten days old, and to repeat it at the intervals which experience on the farm in question indicates until the lambs are past the dangerous age."

Biochemical Investigations.

Several pages are devoted to figures in connection with the analyses of blood and urines. There is a lack of definite abnormality, but the figures given should prove of considerable interest to workers on sheep diseases generally.

Conclusion to Part I.

The work, of which details are given in the preceding pages, has had as its object the elucidation, by approach from a number of different angles, of the factors which predispose lambs to pulpy kidney disease. That goal has not yet been reached, but it is felt that the data which have been gathered and the observations and analyses that have been made have provided a solid basis and cleared the ground for further experimental work of a more exact and detailed nature.

The pasture, soil, ewes' milk and blood analyses which have been carried out all point to the excellent environment which the lambs enjoy in affected areas. On the other hand, (1) the remarkable manner in which the disease tends to confine its attack to lambs that are in the process of changing over from a milk only to a milk plus herbage diet, and (2) the relation which has been shown to exist generally between the incidence of the disease and the increased quantity of milk yielded by ewes under favourable conditions, and hence the rapid growth rate of the lambs, are striking facts which point to a definite relationship between alimentation and the occurrence of the disease. Whether this relationship is bound up with the greater general susceptibility of rapidly growing and thriving young animals to anaerobic infection (*e.g.*, blackquarter of calves and braxy of hoggets), or whether, as seems more probable, some digestive disturbance is apt to occur at that stage of life, affecting particularly those lambs which are getting the largest supplies of milk, one cannot say. Very possibly a combination of these two factors is involved. The preventive effect of periodic yarding and of daily exercise is in favour of the latter explanation. It suggests that possibly a gradual change in the *p*H, or the degree of the digestion of the food as it traverses the small gut, and that only after some days, in most cases, is the change sufficient to give the organisms that are responsible for the disease a footing there. Some such explanation would explain the preventive effects of both yarding and exercise equally well. The exercise would daily hasten and increase peristalsis, thus preventing this hypothetical change from occurring. Yarding would tend to empty the lamb's bowel and to alter the *p*H and before the inimical change

XUM

which had thus been overcome had again progressed far enough to facilitate the organism's toxigenic activities, a further yarding would once more counteract it.

To elucidate fully the mechanism of the predisposing factors in this disease will be difficult, but it offers a highly intriguing field of research. Such information is badly needed for the fuller understanding of disease processes in general, and it is intended to carry out further experiments of a more definite nature than can well be conducted in the field.

Part II.

An interesting account is given of the effects of injecting lambs with histamine. (It was at one time thought that the disease was not bacterial in origin.) Although the histamine theory was proved to be untenable, the author thinks that there remains the possibility that some such substance as histamine does actually account for some of the minor features of cases met with in the field.

Bacteriological Investigation.

Gill formed the opinion in 1928 that the disease was due to the absorption of some bacterial toxin from the small intestine. He therefore undertook examinations for bacteria in the intestine. As early as 1927 he had found *B. welchii*-like organisms, but at that time he passed them by because similar looking organisms were found in normal lambs. He certainly did some work on them, but the results were more or less of a negative character. He concentrated for some time on members of the Salmonella group, but still found *B. welchii*-like organisms predominating in the gut. He had read of Williams' theory that in human beings sudden collapse occurred due to the absorption of *B. welchii* toxins caused by obstruction in the intestine, and he carried out some obstruction experiments without positive results. He also knew that lamb dysentery serum neutralises *B. welchii* toxins, and resorted to the use of such serum in two acute cases. These were probably too far advanced to respond. In 1930, Gill set out to find the nature of the toxin in the gut and to isolate the organism.

Toxins in the Small Intestine.—He used mice to demonstrate toxicity, injecting intravenously, and then went on to use lambs, again injecting them intravenously. His method was to shake up the gut contents with four volumes of normal saline, then spin in a centrifuge, and use the supernatant fluid as the inoculum. By such means he was able to show, in 1930, that in the gut of affected lambs there was a toxin, small doses of which would kill healthy lambs when injected intravenously, and that such injected lambs showed symptoms and lesions indistinguishable from true pulpy kidney disease.

While in this country Gill had conferred with Dr. Montgomerie, Bangor, and learned that in North Wales there was some evidence that lambs injected in the field with lamb dysentery serum, in addition to failing to develop typical lamb dysentery, also failed to develop pulpy kidney which was prevalent on some farms in that area. He therefore obtained a supply of lamb dysentery serum from the Wellcome Physiological Research Laboratories, and tried it in the field on

XUM

his return to New Zealand. His result was: 410 lambs inoculated; death from pulpy kidney, 4, or 1 per cent. 1,300 lambs control on same farm; deaths from pulpy kidney 52, or 4 per cent. This suggested that the type of toxin produced in the intestine was one that the lamb-dysentery serum would neutralise, and strengthened the suggestion that a member of the *B. welchii* group of organisms was the responsible agent.

Isolation of organisms of the *B. welchii* group present in the intestine of affected lambs was now carried out. Details of the method adopted are given. He proved that the cultures were not classical *B. welchii*, as a pure *B. welchii* antitoxin would not neutralise their toxin. He found his cultures differed from the lamb-dysentery organism (Dalling) in that they fermented glycerine, produced acrolein when grown in glycerine, and liquefied solid serum. He found further that they differed from Bennetts' *B. ovitoxicus* in that they liquefied solid serum.

He now had to attempt to classify his organism by toxin-antitoxin neutralisation tests. He made antitoxin in a rabbit from one of his strains, and found that in addition to neutralising the toxin produced by his own isolated organism, it neutralised toxin prepared from Bennetts' *B. ovitoxicus*. He found, further, that *B. ovitoxicus* antitoxin neutralised the New Zealand toxin, and he assumed that his cultures were identical with Bennetts' *B. ovitoxicus* except in their behaviour on solid serum. A supply of lamb dysentery toxin and antitoxin was obtained from the Wellcome Laboratories, and cross immunisation tests were carried out. Gill found that the lamb dysentery antitoxin supplied to him consistently failed to neutralise the toxin prepared from his organism. He further showed that the same sample of antitoxin failed to neutralise the toxin of Bennetts' *B. ovitoxicus* (this was in opposition to Bennetts' findings; he showed that a sample of lamb-dysentery antitoxin completely neutralised his toxin). Gill then recalled that he had some of the original lamb-dysentery antitoxin sent to him from the Wellcome Laboratories in 1930, and which he had used on two lambs. He found that this simple completely neutralised the toxins of his own culture and Bennetts' *B. ovitoxicus*. He found it difficult to correlate these results. [A note on this variation in the antitoxins of lamb dysentery organism appeared in this Journal, where it is shown that the capacity of the organism to produce *B. ovitoxicus* toxin as well as lamb-dysentery toxins and hence the two antitoxins, was lost about 1930: this explains Gill's difficulty.—ED.] *B. paludis* (McEwen) antitoxin failed to neutralise the New Zealand toxin. Gill concluded from his various investigations that the cultures he had isolated were species of *B. ovitoxicus*, and because of the slight cultural difference from Bennetts' *B. ovitoxicus*, he suggests that the "New Zealand strain be known as *B. ovitoxicus*, var. *N.Z.*"

Artificial Production of the Disease.

Gill attempted to reproduce the disease by feeding cultures of his organism. He tried Bennetts' method as well as various others, but up to the present he has been unable to reproduce the typical disease by any method of feeding cultures.

XUM

He next tried inoculation of toxic culture filtrates. One lamb received 100 c.c. intramuscularly, and died sixty-five minutes later. A second lamb received 25 c.c. by the same route, and died within a few hours. From the symptoms and lesions described there seems little doubt that the true picture of this disease was produced. The histological findings supported that reproduction had been successfully achieved.

A series of experiments were next undertaken to demonstrate whether " pulpiness " is specifically due to the toxin of *B. ovitoxicus* species. In these experiments toxins of the lamb dysentery organism (Dalling) and *B. paludis* (McEwen) were used, and from the results it was deduced that " the length of time that the kidney was exposed to circulating toxin before death occurred was a powerful factor in the occurrence of the pulpy change " ; and, further, that " it is quite conceivable that pulpy kidney may not be a strictly specific disease at all, but may result from different organisms in different countries or localities."

Vaccine and Antitoxin in the Field.

Vaccine.—Formalinised vaccine was made and tested on lambs. The first tests were made on three lambs by injecting 5–10 c.c. (one injection), drawing samples of blood from them at periods up to sixty-four days after vaccination, and testing the neutralising power of the serum on toxin, using mice intravenously. In two lambs satisfactory immunisation had taken place. A field trial was then undertaken. Lambs on disease farms were injected with vaccine at about a week old. In all, 727 lambs on six farms were injected, and 549 controls on the same farm were left untreated. The result was that nine (three doubtful) of the injected lambs died of pulpy kidney, while twelve of the controls died. The author thinks that two doses of vaccine might have given better results.

Antitoxin was prepared in horses by the use of " anaculture," followed later by filtrate. The antitoxin was shown to be highly potent by the mouse intravenous test. A field experiment was carried out in which 1,067 lambs on nine farms were inoculated with 5 c.c., and 1,072 control lambs were left untouched. Among the inoculated, three (two doubtful) died of pulpy kidney, whilst among the controls twenty (one doubtful) died. This experiment indicates strongly that " antitoxin can be used in future outbreaks among valuable lambs with some confidence."

Conclusion of Part II.

(1) It has been shown that a very potent toxin exists in the small intestine of lambs affected with pulpy kidney disease, and that no such toxin can be detected in a similar situation in normal lambs. (2) The inoculation of this toxin into the blood stream of healthy lambs induces a condition which is indistinguishable, both ante- and post-mortem, from pulpy kidney disease. (3) The toxin in the affected lamb's gut is neutralised by antitoxins of *B. ovitoxicus* (strongly), and the L.D. bacillus (weakly). It is not neutralised by antitoxins of *B. welchii* nor *B. paludis*. (4) From these toxic small-gut contents an organism resembling *B. welchii*

XUM

morphologically, and in most of its cultural reactions, can be grown, generally in almost pure culture. (5) This organism under suitable conditions of growth produces a toxin having the same toxin-antitoxin relationships as that found in the affected lamb's intestine, and antitoxin prepared against the toxin of this organism will neutralise toxins of *B. welchii*, *B. ovitoxicus*, and New Zealand pulpy kidney strains. It will not neutralise toxins of L.D. bacillus nor *B. paludis*. The organism therefore agrees with *B. ovitoxicus* (Bennetts) in its toxin-antitoxin relationships. (6) Since all New Zealand pulpy kidney strains of the organism have been found to be strong serum-liquefiers, whereas *B. ovitoxicus* causes no liquefaction of that medium, and since differences in the toxins of the two organisms may later be detected (such as Bennetts' work first showed to exist between the toxins of *B. paludis* and the L.D. bacillus), it is suggested that the New Zealand organism be known in the meantime as "*B. ovitoxicus*, var. *N.Z.*" This is suggested pending the renaming of this group of organisms as varieties of *B. welchii*, which appears to be a widely recognised need. (7) Toxic culture-filtrates from *B. ovitoxicus*, var. *N.Z.* induce a condition indistinguishable from pulpy kidney disease when injected intramuscularly into lambs. The kidneys become markedly pulpy a few hours after death. (8) Evidence is put forward that this organism or *B. ovitoxicus* need not necessarily be the cause of pulpy kidney disease in all countries, as toxins of other members of the *B. welchii* group (L.D. bacillus and *B. paludis*) can induce very similar lesions on injection into lambs. (9) In field trials of anaculture-vaccine, prepared with *B. ovitoxicus*, var. *N.Z.*, no appreciable protection was afforded, but antitoxin gave highly encouraging results. It should be of great value in checking outbreaks among valuable lambs (stud flocks). (10) While Koch's postulates have not been fulfilled, it is felt that the evidence summarised above is ample to incriminate this organism's toxin as the immediate cause of deaths from pulpy kidney disease in New Zealand. Predisposition, probably by a digestive disturbance, has been discussed in Part I.

Addendum.

Since writing his report, Gill has had the opportunity of examining Wilsdon's *B. welchii* (type D), and comparing it with his own cultures. His conclusions are: "While the small amount of work that has been done admittedly needs to be repeated and confirmed, it has gone far to show that the *B. welchii* type to which the writer gives the temporary name of *B. ovitoxicus*, var. *N.Z.*, is identical with that which Wilsdon calls *B. welchii*, type D. Nevertheless, it is mainly the thermolabile toxin which is present in the gut of lambs affected with pulpy kidney, and also in that of sheep affected with infectious entero-toxæmia, not the thermostabile fraction."

Gill's report is a very valuable contribution to our knowledge of sheep diseases, and is well worth a careful perusal. We understand that copies may be had on application to the officer in charge, Veterinary Laboratory, Wallaceville, Private Bag, Wellington, New Zealand.

XUM

THE EFFECT OF A CALCIUM DEFICIENT DIET ON PREGNANT EWES.

By A. H. H. FRASER, W. GODDEN, and W. THOMSON.

(*The Rowett Research Institute, Aberdeen.*)

THE object of this communication is to record certain experimental observations on the production of pregnancy toxæmia in ewes as a result of a calcium deficient diet. The condition of pregnancy disease, or pre-parturient paralysis of ewes, was first described by Gilruth[1] in New Zealand. Subsequent study has shown it to be a cause of widespread losses under the more intensive methods of sheep husbandry. Dimock[2] and his associates found the blood calcium lowered in this condition, the average calcium figure in seven normal ewes being 9.1 mg. per cent., while in thirteen ewes suffering from pregnancy disease, the average figure was 6.6 mg. They considered that a lowered blood calcium is an important predisposing factor in the production of pregnancy disease of ewes, and that its prevention depends upon the proper supply of calcium in the ration. Matthew[3] records that South African farmers use bone-meal as a preventive. On the other hand, Greig[4] found normal blood calcium figures in his cases of pregnancy disease, and Roderick and Harshfield[5] record a case of heavy losses in a flock fed alfalfa hay, and with free access to oyster-shell flour.

In an experiment in progress at this institute, four pregnant ewes were fed the following ration : *Meals*—Flaked maize, four parts ; crushed oats, one part ; medium bran, one part ; linseed cake meal, one part ; raw potatoes, seven parts ; chopped hay and straw (equal parts), two parts ; salt (NaCl), 10 grams per day ; C.L.O., 2½ c.c. per day.

Four ewes of the same breed and age, in lamb to the same ram, and kept under identical conditions, were fed the same ration supplemented by calcium in the form of : Ground chalk, 13.5 gm. per sheep daily ; calcium lactate, 13.5 gm. per sheep daily. Both groups were kept confined in pens with small outside cement runs, with moss litter as bedding. Periodical blood analysis of Ca and P and mineral balance determinations were made during the course of the experiment.

The average daily intake of CaO was 1.58 grams, and P_2O_5, 8.6 grams on the basal ration, and 11 grams of CaO, and 10 grams of P_2O_5 on the supplemented ration. Over the period July 16th to April 12th, the balance experiments showed an average daily loss of 0.19 gram of CaO, and a gain of 0.49 gram of P_2O_5 by the ewes on the basal ration, and an average daily gain of 1.72 gram of CaO, and 0.73 gram of P_2O_5 by the ewes on the supplemented ration.

Results.—The results showed that the basal ration led to a lowering of blood Ca, the development of the symptoms and post-mortem appearances of pregnancy

disease, and to the death of the ewes. Average blood calcium figures* in the two groups taken at intervals of three weeks are shown below :

DATE :	24/11/32	15/12/32	5/1/33	26/1/33	16/2/33	28/2/33	9/3/33	30/3/33	20/4/33
Group I	8.2	9.2	9.3	9.6	9.0	8.2	8.0	7.6	8.8
Group II	10.8	10.7	10.9	11.3	10.6	11.9	10.9	10.8	9.5

The figures for Group II lie within the normal range throughout, but those for Group I during the last months of pregnancy are definitely subnormal. Lower blood calcium figures were obtained with individual ewes in Group I at the onset of paralytic symptoms. Thus, ewe No. 38, which died on 16.3.33, had a serum Ca level of 6.3 on 13.3.33 ; ewe No. 40, which began to show symptoms of disturbance on 4.4.33, had a serum Ca level of 5.95 on 5.4.33 ; and ewe No. 41, which had to be allowed to graze on 5.4.33, then had a serum Ca level of 6.15.

Throughout pregnancy only one ewe in Group II (No. 42) showed any signs of disease. She was noted to show signs of staggering on April 16th. On April 19th, she lambed triplets. The lambs were premature and weak, one was dead-born, one died shortly after birth, the third only survived one day. The ewe had little milk, and the after-birth was retained. This sheep eventually survived and made a good recovery. None of the basal group retained their health. By January 26th, three ewes (Nos. 38, 39 and 41) were slightly bent in their legs, and down on their pastern joints. By February 9th, it was found necessary to reduce their ration,since they rejected half of the food put before them. This failure of appetite was progressive, and some of the ewes eventually refused food altogether. Three of the four ewes showed disordered locomotion, staggering, weakness of the legs, tonic and clonic convulsions, and paralysis. The symptoms observed are fully described in the individual case histories. Two of the ewes died. Of the remainder, one was allowed to graze for a certain period each day, the other grazed, and was finally fed lime to tide her over lambing.

Only two living lambs were secured from the four ewes (compared with seven in Group II), and these two lambs were weakly, and out of ewe 41, which received a lime supplement before lambing. The post-mortem appearances in the two ewes that died were very similar. Inflammation of the gastro-intestinal tract, fatty degeneration of the liver, and *in utero* death of the lambs were the predominant features.

Discussion.

The important result of this investigation was the finding that ewes on a calcium deficient diet were unable to complete a normal pregnancy under the conditions of the experiment. The number of ewes was admittedly small, as the main object of the experiment was the determination of mineral balances. Nevertheless, the result is more than suggestive. It is probable that all the ewes in the basal group would have died had they been confined to their basal

* We are indebted to Mr. W. M. Allcroft for making these serum Ca estimations.

XUM

ration, and that they would have produced no living lambs. As a result of the calcium deficiency of their diet, which was reflected in a subnormal calcium content of the blood, all the ewes became ill. It is noteworthy that in their treatment the feeding of lime was more effective than the subcutaneous injection of calcium gluconate.

The symptoms and pathological lesions were similar to those described in the naturally occurring disease of pregnant ewes termed " pregnancy disease " or " preparturient paralysis." It is not suggested that this syndrome is invariably the result of a dietary calcium deficiency. There is good evidence against such a view ([4], [5]). On the other hand, lack of exercise is generally recognised as a factor favouring toxæmias of pregnancy, and both groups of sheep in the experiment were under conditions of close confinement. It is possible that the ill-health resulting from calcium deficiency made the ewes succumb more readily to other causes of toxæmia. It is also possible that the anorexia ascribable to the calcium deficiency resulted in partial starvation and acidosis, which, combined with the acidosis of pregnancy, caused pregnancy disease. The important deduction which may be legitimately made from the experiment described is that a calcium dietary deficiency may precipitate an outbreak of pregnancy disease of ewes which would not otherwise have occurred.

Case Histories.

Ewe 38.—June 26th, 1932 : put on basal ration. August 29th, 1932 : weaned. December 8th, 1932 : mated. January 26th, 1933 : slightly bent in legs and down on the pastern joints. March 10th : completely off food and weak in fore-legs. March 11th : 100 c.c. castor oil and 5 grains calomel administered, water given by bottle and regular exercise prescribed ; ewe staggered slightly while walking. March 12th : seven grains calomel given. March 13th, 6 a.m., had difficulty in rising, and showed staggering gait ; 9.15 a.m., 60 c.c. calcium gluconate sol. injected subcutaneously ; 9.45 a.m., getting up and walking better, but still weak on legs ; refused all food ; given milk and gruel by bottle. March 14th : walking fairly well, but refuses to eat ; given water, milk and gruel by bottle ; temperature subnormal. March 15th : weaker on legs ; temp. normal ; grew worse during day, and drank much water ; 5 p.m., temp. 106° ; unable to rise, breathing laboured. March 16th : 6.30 a.m., temp. 106° ; unable to rise ; 8 a.m., died suddenly.

P.-M. Examination (by H. M.).*—Lungs congested. Liver congested and fatty. Gall-bladder much inflamed. Kidneys showed congestion and fatty degeneration. Mucosa of abomasuum intensively inflamed and scraped off easily, pyloric region less affected. Almost the entire intestinal tract inflamed. Uterus contained two lambs, male and female : both appeared to have been dead several days. Membrane of uterus inflamed and degenerated.

* We are indebted to Dr. H. E. Magee for making this post-mortem examination.

XUM

Ewe 39.—June 26th, 1932: put on basal ration. August 29th, 1932: weaned. December 8th, 1932: mated. January 26th, 1933: slightly bent in legs and down on the pastern joints. March 17th: regular exercise begun. April 17th: noted to have staggering gait. April 24th: entirely off feed, walking unsteadily and having convulsive fits. April 25th: condition worse; falls over in convulsions when anyone enters pen; 60 c.c. calcium gluconate injected subcutaneously; some improvement, but ewe did not eat. April 27th: ewe died.

P.-M. Examination (by A. F.).—Ewe in fat condition. Lungs congested, one lobe pneumonic. Liver pale, friable and fatty. Kidneys congested. Whole of intestinal tract inflamed. Uterus contained two lambs, one normal, the other appeared to have been dead some days.

Ewe 40.—June 26th, 1932: put on basal ration. August 29th, 1932: weaned. December 7th, 1932: mated. March 17th: regular exercise begun. April 4th: stiff and trailed hind legs slightly. April 5th: allowed to graze for fifteen minutes; ate very little. April 6th: staggering slightly. April 8th: grazed thirty minutes; nothing eaten from troughs. April 9th: ate nothing; not grazed. April 10th: showed sudden stiffening and spasmodic jumping; ate a little grass. April 11th: walking normally; grazed well for one hour. April 12th: improving; grazed one hour. April 21st: eating no meals, but cleaning up potatoes. April 25th: lambed two dead lambs: both lambs appeared to have been dead some weeks; ewe turned out to grass.

Ewe 41.—June 26th, 1932: put on basal ration. August 29th, 1932: weaned. December 10th, 1932: mated. January 26th, 1933: legs slightly bent and down on pastern joints. March 17th: daily exercise begun. April 5th: grazed fifteen minutes; refused meals. April 8th: grazed well for thirty minutes; nothing eaten from troughs. April 21st: eating no meals, but cleaning up potatoes. April 27th: fed 5 gm. chalk by spoon. April 28th: fed 400 gm. meals + chalk: this was eaten greedily, being the first meals eaten for three weeks. April 29th: fed 200 gm. basal meals + chalk alongside 200 gm. basal meals without chalk; basal + chalk meals were eaten greedily, but the meals without chalk were left untouched. April 30th: fed 400 gm. basal meals + chalk; all was eaten. May 3rd: lambed twins; normal lambing; ewe has little milk and lambs weak.

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XUM

Clinical Articles

Tetanus Immunisation.

By F. C. SCOTT, M.R.C.V.S.
Pontefract.

In a stud of one hundred and seventy colliery horses, in which tetanus had been almost unknown, five cases of a very acute and fatal type occurred between the months of July, 1930, and January, 1931. As the cases occurred at intervals of, roughly, one month, the transient immunity produceable by antiserum injection did not offer much prospect of the prevention of further cases; active immunisation of the whole stud by the use of anatoxin was therefore decided upon. A supply of anatoxin was obtained from abroad, and the whole stud was treated. A further case of tetanus, however, occurred in July, 1931; a second one in August, two further cases in September, and a fifth in October.

The occurrence of these cases gave cause for alarm, and it was decided to ask the help of the Wellcome Physiological Research Laboratories. I may at this point express my indebtedness to the Director of the Laboratories for arranging to make material available to me, and in particular to Mr. Glenny for general help, and making toxoid and carrying out the titrations.

In October it was decided to take samples of blood to test the sera for antitoxin content, and so arrive at some conclusion as to whether a serviceable immunity existed in a majority of the stud or not. For this purpose twenty-five samples of blood were taken and sent to the laboratories. Twenty-four of the animals possessed no detectable antitoxin, whilst one showed the minimum amount for which it was possible to test; it was clear that the "anatoxin" used had not produced any material immunity. Consequently it was decided to commence the immunisation anew. A batch of "alum toxoid"* was prepared for the purpose. As a substance—in this case alum—is added to the "toxoid" intentionally to create a local reaction, and thereby a better immunity, any effects of the expected local reactions on the general health or harness fitting of the stud had to be provided for; it was necessary to keep the mine working, and one could not risk the possibility of more than a minority of the animals being off work at one time.

Accordingly, only one animal received toxoid on the first day—October 23rd, 1931; as there was little local reaction on the 24th, five more animals were injected. Observation on the 26th was made, and showed three to have swelling which was just noticeable, one practically none—the pony treated on the 23rd; a fifth showed a swelling 2½in by 2½in., whilst a sixth showed the most reaction, 4 in. by 3 in. The reaction of the sixth pony was such that it would not interfere

* The use of "alum toxoid" was described in THE VETERINARY JOURNAL, Vol. 88, No. 3, pp. 90-98.

XUM

with working. Five of the sites of injection were normal by the seventy-second hour, the sixth one was on the wane. As the result of these preliminary injections it was decided that it would be perfectly safe to treat the whole stud at one intervention if desired, without any likelihood of disorganising the working routine; but in case some unforeseen factor might arise causing disablement of the horses, it was decided to treat them in batches. Times such as week-ends were chosen for making the injections, as a rest of forty-eight hours was assured. The injections were made high up on the neck, so that any possible swelling would not extend to the site of the collar. Sixty-three animals received toxoid on October 31st. Instructions were given that any animal showing swelling exceeding 4 in. by 3 in. at the forty-eighth hour was to be left in the stable as a precautionary measure; some three or four ponies were left in, but all of these were fit for work had they been required. About half of the ponies showed a slight swelling less than 2½ in. by 2½ in.; the remaining half showed none discernible to the eye, but in some of these a very slight "fluffiness" was discernible on palpation.

Twenty-five were treated on November 5th; these were due to work on the 6th, and in no case was one kept in on account of local reaction. Sixty-five were treated on November 7th, and all worked on the 9th. The report on November 7th and 9th, on the reactions following injections on November 5th and 7th, showed that they were as mild as those made earlier. As a result of the experience gained, one was satisfied that one could treat a whole stud in future without fear of disabling reactions.

On November 28th, 1931, twenty-four further samples of blood were taken from the animals which received toxoid on October 31st and November 5th and 7th; these were submitted to tests for antitoxin value. Five of the ponies had between 0.01 and 0.1 unit of antitoxin per c.c.; twelve had between 0.1 and 1.0, seven had between 1 and 3 units per c.c. Since a unit of antitoxin roughly corresponds to 1,000 lethal doses of toxin, it is clear that in all these ponies a considerable immunity had been produced.

The occurrence of the original five severe cases of tetanus, and of the second series of five cases later, showed that this mine contained a widespread infection, and that unless the immunisation was lasting more losses would certainly occur. The immunity presented by the figures mentioned was high, but it was highly desirable to exalt it to such a degree that a long time must elapse before the animals would again be susceptible to an ordinary fatal dose of toxin, and if possible to render the immunity life-long. A second treatment of the stud was therefore carried out, the majority (128) receiving toxoid on January 2nd, 1932; the minority (38) on June 16th and 18th, 1932. The injections this time were made on the opposite side of the neck to those made on the first occasion. Local reaction was similar in the January batch to those noted formerly; the June batch, however, showed less marked reactions, in fact in most cases it was with difficulty they could be detected by palpation. Additions have been made to the stud in the meantime, and each of these has received two doses of toxoid at an interval of one month.

XUM

Fifteen months had elapsed since the first injections of toxoid were made (October, 1931–February, 1933), and no cases of tetanus had occurred in the meantime, so that it was desirable to know the status of the existing immunity; should it be high, one would expect that it would diminish slowly, but be adequate for life; should it be low, further steps to perpetuate the immunity would be called for. Twelve samples of blood were taken for test: six being from animals which received toxoid on two occasions with an interval of six to eight weeks, six from animals where there was a lapse of seven months between the injections.

Result.—The serum of one horse contained between 0.001 and 0.01 unit per c.c.; two between 0.01 and 0.1; seven between 0.1 and 1.0; and two contained 1.0 unit. This degree of immunity is probably quite sufficient to give the animals complete protection. The important point is that the body cells of all have learned to make antitoxin when a specific stimulus is applied; therefore, if tetanus bacilli settled in a wound in any of these ponies and commenced to make toxin locally, the cells of the animal would almost certainly respond with an immediate and overwhelming production of antitoxin.

A point of interest is that whereas nine of the ten ponies originally affected developed very acute symptoms within twenty-four hours of onset and had to be immediately destroyed, one showed milder symptoms and gradually recovered. The odd feature is that the blood of this horse, titrated at the laboratories a month after recovery, and again four months later, contained no detectable antitoxin, *i.e.*, less than 0.0002 unit per c.c. This pony dropped dead from sudden heart failure with working, in January, 1933, and therefore no further observations could be made.

Summary.—Five cases of tetanus occurred among some pit ponies in six months. Foreign commercial "anatoxin" was injected. Five further cases occurred during the next four months. A sample of blood from each of a group of ponies which had received "anatoxin" was tested: twenty-four contained no detectable antitoxin, and one showed 0.001 unit. In view of this disturbing discovery that the ponies were not immunised, alum toxoid and toxoid were injected. Tests of the blood made about a month and fifteen months later showed titres ranging from 0.01 and 3 units per c.c.; this indicated a reasonably high and lasting immunity. No cases of tetanus have occurred since the alum toxoid and toxoid were used, and all incoming ponies are now immunised as a routine.

A Case of Abdominal Hernia in a Cow.

By J. L. BUCKINGHAM, M.R.C.V.S.

Harleston, Norfolk.

Subject.—Jersey cow. *History.*—The owner asked us to come as soon as possible, as he had a cow with a rupture in the left flank. He had noticed nothing wrong with her until half an hour previously, when the fact that she refused her

food caused him to "look round her." The ground near the meadow gateway through which she had passed was very slippery, and it is probable that the cow's foot slipped here and caused a rupture of the musculo-aponeurotic covering of the abdomen We also thought the owner's suspicion of a rupture was probably erroneous, as in our experience this condition is not at all common in dairy cattle. We often find a cow suffering from a hæmatoma or an abscess in the flank when the owner suspects a rupture.

Examination, however, proved that this particular case was one of abdominal hernia. There was a very large swelling in the left flank; the swelling being as big as the body of a full-grown sheep. The hernial opening was discovered in the left flank, about halfway between the stifle and the ribs, and about two-thirds the distance from the spinal column to the linea alba. Attempts at reduction proved fruitless owing to the large volume and weight of the hernial contents. The cow was dull and listless, and had not eaten the corn and cake which had recently been put in the manger. We also noticed that her feet were badly shaped. The hind feet were greatly overgrown and needed trimming. This would cause her to have a bad foothold on slippery ground.

Treatment.—Saturday, May 13th, we examined the cow, and told the owner to fast her until the following Monday, but to allow her to have water to drink. May 15th, we administered the following draught:

℞	Chloral hydras	ʒii
	Aquæ	q.s.
	Theriacæ	Oii
	M. ft. haust.	

The cow was then cast by Reuff's method, and placed in the dorsi-recumbent position. The legs were secured with ropes, the left hind leg being extended backwards. The site chosen for incision through the skin was above and behind the hernial ring. This was done so that if post-operative hernia occurred there would be little danger of the hernial contents breaking through the skin wound. The site of the operation was clipped, shaved, and painted with spirit and iodine. Five c.c. of tutocain with adrenalin were then injected subcutaneously, and an incision made of sufficient size to admit the hand. It was then found that the parietal peritoneum was ruptured. The hernial contents were returned with much difficulty through the small hernial ring, which was then sutured.

The left hind leg was now extended forwards, and the skin wound sutured, after which the cow was allowed to rise, and was well rubbed down. The wound at first healed well, and no dressing was considered necessary. Five days after the operation, however, the skin wound became infected, and a solution of hydrarg. perchlor., 1 in 1,000, was applied twice daily. The hernia was completely cured by this operation, the only untoward incident being somewhat tardy healing of the skin wound.

XUM

The Treatment of Sterility in Cows with Wheat-Germ Oil (Vitamin E).*

By J. F. TUTT, F.R.C.V.S.
Winchester.

It is apparent that it is futile to apply this treatment when there is clear clinical evidence of those diseases generally recognised as causing sterility, and also in those cases where the after-effects of such diseases have left irreparable changes in the genital apparatus. The first batch of cases on which this treatment was tried proved absolute failures through neglect to recognise this fact.

A table is appended of 25 fully recorded cases, and of this total 17 became pregnant, and eight remained sterile, although some of these eight later became pregnant after further and different treatment.

In each of the cases here described, the wheat-germ oil followed after the other treatment, waiting until œstrus had become normal, and service carried out at the second normal heat. The course adopted has been to repeat the injections where practicable at intervals of six to eight days, making the injections as deeply as possible into the gluteal muscles. The site of injection is important. In a fair proportion of the cases a reaction in the nature of a swelling has followed, accompanied by a moderate degree of stiffness, but this has subsided without ill effect. Under no circumstances should the injections be made into the pectoral muscles. In one instance when the writer was away and a few cows under treatment received the injection by an assistant into these muscles, large and persisting swellings followed, which were a great trouble to reduce.

The preparation of wheat-germ oil used has been obtained through Messrs. Willows, and made by the British Drug Houses, Ltd., London. The dose has been 25 c.c. per injection. The practitioner will naturally ask on what type of case this line of treatment should be tried, and without hesitation it can be stated that the case selected should present the following characteristics:— (1) Œstrus must be present and regular. (2) That there is no clinical evidence of disease in the ovaries, Fallopian tubes, uterus and vagina. In cases of vaginitis, even though œstrus is normal and there is no other evidence of disease, the vaginitis must be cured first. (3) That where there is such clinical evidence the disease present must be cured and sufficient time allowed to elapse before resorting to wheat germ. Injections should not be made until after service at the second heat after treatment. (4) That the object of the wheat-germ oil appears to be to preserve pregnancy in its earliest stages. In this respect it is somewhat comparable to the action attributed to injections and extracts of corpus luteum. In women the use of this preparation has been claimed to prevent abortions in the earlier months of pregnancy.

It is not denied that in some of the cases recorded which became pregnant, pregnancy may have followed as a result of the other treatment, which in each case preceded the use of wheat-germ oil. Cases such as 3 and 25, in which its value is clearly shown, do not occur with relative frequency in general practice.

* This method of treatment was first described by P. Vogt-Moller and F. Bray in THE VETERINARY JOURNAL, Vol. 87, 1931, pp. 165–170.

XUM

No.	Class of animal	Name.	Age	Previous history	Clinical findings	Treatment other than Wheat germ oil	No. of Wheat Germ Injects	Result
1	Guernsey cow	Francoa	4	Served first on July 10th, 1930, and calved heifer calf on 13/4/1931. Served 25/6/1931 and 18/7/1931, and 6/8/1931. In œstrus again 5/9/1931, and then examined	Endometritis	Lugol, 1%; 250 c.c. unto uterus. Served 23 and 24/11/1931	3	Pregnant; calved 30/8/1932
2	Shorthorn cow	"S"	6	Aborted last calf; blood test positive; irregular œstrus	Cysts in both ovaries; endometritis	Cysts ruptured; Lugol, 1%; 250 c.c.; two injections of contamine	1	Pregnant
3	Guernsey cow	"C"	6	Normal; regular œstrus	Nothing abnormal	None	3	Pregnant
4	Friesian cow	"Philip"	5	Normal; irregular œstrus	Cystic ovaries; endometritis	Cysts ruptured; Lugol, 1%; 250 c.c.; two injections of contramine	2	Sterile
5	Guernsey cow	"C"	5	Past calving history normal; in œstrus every 20–23 days	Cyst left ovary; slight endometritis	Cyst ruptured; Lugol, 1%; 250 c.c.; two injections of contramine	3	Sterile; became pregnant later after further treatment with Lugol, 1%
6	Guernsey cow	"C"	6	Normal; regular œstrus	Cervicitis; endometritis (slight)	Os required dilating to admit catheter; Lugol, 1%; 250 c.c.	2	Pregnant
7	Red and white Shorthorn cow	"East"	5	Calved to full term 1/12/31; inoculated with living abortus vaccine as a heifer; no œstrus observed since calving up to 30/3/32	Corpus luteum persistens left ovary	Expression of corpus luteum; two injections of contramine (30/3/32 and 6/4/32); œstrus observed between these dates and service carried out	2	Pregnant

No.	Class of animal	Name.	Age	Previous history	Clinical findings	Treatment other than Wheat germ oil	No. of Wheat Germ Injects	Result
8	Crossbred Friesian and Shorthorn cow	"East" 4	5	Last calving normal, 20/10/31; In œstrus 4/12/31, 25/12/31, 16/2/32, 6/3/32, 28/3/32	Cysts both ovaries	Cysts ruptured; two injections of contramine	1	Pregnant
9	Roan Shorthorn cow	Seld	6	Aborted last calf; blood test positive; irregular œstrus	Cysts both ovaries; slight degree of endometritis	Cysts ruptured; two injections of contramine	2	Sterile
10	Red Shorthorn cow	Seld	7	Aborted at fifth month of pregnancy 6/6/31; blood test positive; in œstrus 21/10/31 and 29/11/31, and served on these dates. In œstrus again January 28th, but not served	Cyst left ovary; endometritis	Cyst ruptured; two injections of contramine, one Lugol, 1%, 250 c.c.; returned to service April, 1932, and wheat germ then injected	2	Sterile
11	Roan Shorthorn cow	Seld	5	Went to full term, but the placental membranes required removal; blood test positive; 22/8/31, service delayed until 5/10/31 owing to uterine discharge. Œstrus reappeared on 1 and 21/12/31 and 16/1/32	Endometritis	Lugol, 1%; 250 c.c.; two injections of contramine	2	Pregnant
12	Roan Shorthorn cow	"Bege"	6	Calved normally six months before examination on 1/4/32; no œstrus observed. Heavy milker	Nothing abnormal	Theelin, two injections, and ovarian massage induced œstrus, but not holding to services	3	Sterile
13	Black and white Shorthorn cow	"East" 175	—	Calved 8/12/31. In œstrus 5/2/32, 16/3/32. Has received living abortus vaccine as a heifer	Cysts both ovaries	Cysts ruptured; two injections of contramine	2	Pregnant
14	Roan Shorthorn cow	"East" 166	—	Calved 22/11/31; in œstrus 17/1/32, 28/2/32, 8/3/32. Has received living abortus vaccine as a heifer	Cyst right ovary	Cyst ruptured; two injections contramine	2	Pregnant

XUM

No.	Class of animal	Name.	Age	Previous history	Clinical findings	Treatment other than Wheat germ oil	No. of Wheat Germ Injects	Result
15	Red Shorthorn cow	"East" 169	—	Calved 1/12/31; in œstrus 10/3/32, 28/3/32. Has received living abortus vaccine as a heifer	Cysts both ovaries; endometritis	Cysts ruptured; two injections of contramine	3	Pregnant
16	Roan Shorthorn cow	"East" 167	—	Calved 22/11/31; no œstrus observed up to 30/3/32. Has received living abortus vaccine as a heifer	Cysts both ovaries	Cysts ruptured; two injections of contramine	2	Pregnant
17	Red and white Shorthorn cow	"East" 137	—	Calved 24/12/31; in œstrus 10/3/32, 30/3/32. Has received living abortus vaccine as a heifer	Cysts both ovaries	Cysts ruptured; two injections of contramine	1	Pregnant
18	Black Shorthorn cow	"East" 174	5	Calved 4/12/32; in œstrus 6/2/32, 25/2/32, 16/3/32	Cysts right ovary	Cysts ruptured; two injections of contramine	2	Pregnant
19	Roan Shorthorn cow	"East" 153	6	Calved 23/9/31; in œstrus 29/1/32 and 8/3/32	Cystic ovaries; slight endometritis	Cysts ruptured; two ininjections of contramine	2	Pregnant
20	Guernsey cow	Roseleaf	3	Served 17/4/30, and calved a heifer calf 2/2/31. Served 5/5/31, 22/6/31, 13/8/31, 4/9/31, 27/10/31, 18/11/31, 11/12/31, 2/1/32	Endometritis	Yatren vaccine (ineffectual). Lugol, 1%; 250 c.c.	3	Pregnant; calved 14/12/32
21	Guernsey cow	Barbara	4	Served 1/11/28, and had a weakling heifer calf on 15/8/29. Served 16/10/29, 24/11/29, and calved 13/9/30. Served 5/11/30 and aborted 10/2/31 (blood test negative). In irregular œstrus since	Endometritis; cystic ovaries	Yatren vaccine (ineffectual); cysts ruptured	3	Sterile. Later became pregnant after two injectionsof Lugol, 1%; 250 c.c.

No.	Class of animal	Name	Age	Previous history	Clinical findings	Treatment other than Wheat germ oil	No. of Wheat Germ Injects	Result
22	Guernsey cow	Ladymaid	4	Served first 25/7/28, and again on 22/8/28, and aborted 31/3/29. Blood test negative. Calved nine days overdue, 16/7/30. Served 12/9/30, and aborted 26/1/31. Irregular œstrus since	Endometritis; cyst left ovary	Yatren vaccine (ineffectual); cyst ruptured	3	Sterile. Later became pregnant after two injections of Lugol, 1%; 250 c.c.
23	Guernsey cow	Glory	8	Calved first calf 13/7/26 (heifer calf). Three services before next pregnancy, when calved again 13/11/27 (heifer calf). Served twice and had bull calf 7/11/28. Served 1/3/29, and had dead bull calf 16/12/29. In irregular œstrus	Endometritis; cysts both ovaries	Yatren vaccine (ineffectual); cysts ruptured	3	Sterile. Later became pregnant after two injections of Lugol, 1%; 250 c.c.
24	Guernsey cow	Fern	6	Calved first calf 4/9/28, seven days overdue (bull calf); second calf (bull calf) on 12/8/29. Served twice and had heifer calf on 23/7/30, sixteen days before time. In regular œstrus since	Endometritis	Lugol, 1 per cent.; 250 c.c.	3	Pregnant; calved 12/9/32
25	Guernsey cow	Rosey	15	Calved full-time live bull calf at last calving, but had placental retention. Blood test negative. Regular œstrus	Nothing abnormal	None. Had received treatment a few years beforehand when difficult to get in-calf	3	Pregnant. Calved to full term on 27/4/32, live bull calf. Came into œstrus six to nine weeks later and held to her fourth service

XUM

Some Aspects of Interdigital Lesions in the Dog.

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A SEARCH of veterinary literature failed to bring to light any reference to the disease known as interdigital cysts until the commencement of the present century. Stonehenge (Walsh), in his numerous books upon the dog and its disease, during the period about 1870, makes no mention of the acute and painful swellings so typical of the malady, although other conditions of the feet are touched upon. Moller and Dollar, in their edition of 1909, do not consider the disease, but their re-issue of 1912 refers to it in the last paragraph of the book. In periodic literature the earliest mention of the condition that could be found is that of July, 1910, in a report of a meeting of the Eastern Counties V.M.A. Mr. F. L. Gooch mentions interdigital eczema in the dog, and makes reference to cysts and abscesses encountered.

During 1911, a contribution to the veterinary press by A.Z. describes his difficulty when faced by a number of cases of painful cysts in the feet of dogs. He remarks that in twenty-six years of practice, including much canine work, he had never before seen a case. Quoting from a Society report of 1917, during a quite detailed discussion of the subject, a member stated that he had seen cases twenty-five years before. Other members present admitted that they had seen little of the disease. Inquiry among the older practitioners and among dog breeders of many years' experience shows that the disease was known many years ago. This paucity of available knowledge would appear to be due to the profession's lack of interest in the dog as a patient until recent years. The increasing importance of the disease coincides with the huge increase in the canine population of the country, and the appearance of the dog as an every-day patient. For a number of years writers and speakers have stressed the probability of the interdigital lesions having origin in the glandular system of the foot. It is strange that no progress has been made when this has been common knowledge.

Acne vulgaris in the human and acne of the feet in the dog have much in common. The severity and chronicity of the disease in both cases is apparent. The lesions produced—blackheads, pustules, abscesses and cysts—are similar, but differentiation of the lesions in the dog is more difficult. The origin of the disease in the dog has probably been clouded by the inflammatory products tending to issue along the line of least resistance, and so into the interdigital space. The sole of the foot in the dog is reinforced by a toughness to withstand injury, but this toughness in its turn tends to prevent deep inflammatory lesions of the skin breaking to the surface, and rather to emerge into the lax tissue immediately above.

The condition in the human has no such parallel. Lesions appear about the face, chest, back and upper arms, all sites which are easily examined. The skin is thinner, and backed by strong fascial or muscular tissue, so that the lesions invariably break to the surface. In the dog the difficulties are greatly increased

XUM

by the usually advanced stage of the disease when first attempts at treatment are made. The sole of the foot is a part that is rarely examined by owners, and a tendency to lick the foot is frequently ignored. Probably the first symptom upon which advice is sought is an acute interdigital lesion, demonstrating the advanced stage of the disease.

The successful functioning of the sebaceous system of the sole is closely bound up with the normal movement of the foot. During progression, contraction, expansion, extension and flexion take place freely, and all these movements are reflected upon the skin of the sole or lower web. The sole is in the form of an inverted pocket between the pads, and from its position is open to much violence. Some protection is afforded this sensitive structure by a growth of long, soft hair, very profuse in some breeds, which acts as a buffer against injury, and a shield against irritating material. Another function of the hair is to prevent friction between adjacent parts of the sole. The hair is protected by an efficient sebaceous system against the macerating action of water. The movement of the sole tends to express the passive glands. Mobility is an outstanding factor in a normal foot, while the reverse is commonly present in the diseased.

In an animal such as the greyhound, the freedom of movement of the various digits is remarkable. Play is possible in every direction, and is necessary for automatic adjustment of the foot when travelling upon uneven ground.

Certain breeds of dogs are what may be called typical sufferers from the disease, while other breeds are seldom affected, although living under almost identical conditions. The least often affected are the young and immature of all breeds, and such breeds as the greyhound, whippet and Alsatian wolf-hound. They are seen to be breeds that are bred almost solely for their speed and endurance, and are possessed of long slender feet, well knuckled up and perfectly formed. This in turn gives the foot a well-opened web or pedal pocket, allowing no friction between the walls. Great freedom of movement is allowed between all the digits, and the pocket is well lined with hair.

The affected type, on the other hand, is bred almost purely for the show bench : Sealyham, Scottish, Fox and Irish terriers, Airedales, Spaniels, Retrievers and Bull-dogs, are all freely affected after attaining maturity. They are required to possess, according to the breed, standard, small, cat-like, round or other specialised pattern of foot. Has this attention to anatomical details been carried too far ? A number of well-bred animals undoubtedly have feet too small for their weight. The digits tend to be too short in the effort to attain the short or round foot, thus closing the pedal pocket, and giving a tendency to self-irritation of this part. This may be some reason for the theory of heredity of this disease.

The predisposing causes of the disease include :—

Age.—The disease seldom occurs in the young animal, but is almost confined to mature animals. As the young and the adult live under very similar conditions,

XUM

this phenomenon may be referred to the immaturity of the sebaceous system in the young. The general secretory system, including the sebaceous, only attains its full tide in the adult.

Breed.—As mentioned before, some members of the affected breeds possess a pedal pocket which is small or distorted, and which, after the onset of any inflammatory process, continues the affection to chronicity by friction between the swollen walls of the sole. An early loss of the hair of the sole, which results from the inflammation, removes a very valuable protection. The painful condition of the sole discourages the dog from the free use of the foot, and many animals will walk with persistent flexion of the second digital joint to relieve the discomfort. This in itself removes from the sole a very necessary stimulant to the evacuation of the sebaceous glands, and they thus tend to become impacted, and available for infection by various organisms.

Hereditary Predisposition.—A predisposition is possible, and may be due to an excessive production of sebum. It will be noticed in affected bitches that a series of interdigital lesions coincides with the onset of the œstral period. The sexual periods of all animals is accompanied by an increase in the sebaceous production.

External Irritants.—These must be included as a factor not infrequently present, which may open the way to invasion of the glands by injurious organisms. Inflammation of the sole may be set up by small wounds and bruises caused by exercise upon newly gravelled roads, the gritty roads of mountainous districts, and by the sand and mud of the beach. Another source of trouble is the newly prepared road surface of tar and its allies. The tar is picked up by the sole or the hair of the sole, and held in long and intimate contact. It acts as a local irritant, and as a mechanical plug to the adjacent sebaceous glands. A hot day, when the tarred roads " bleed," is a frequent source of eczema of the foot. Any of the forementioned factors may open the path for invasion of the sebaceous glands of the sole by various organisms which will ultimately give the chronic interdigital lesions.

The majority of cases are ushered in by an acute attack of pedal eczema. During this stage the animal is manifestly uncomfortable, and takes short, stilted strides. When the lower surface of the foot is examined it will be seen that the whole of the lower web is inflamed, swollen and painful. Upon attempting to extend or separate the toes to facilitate the examination of the pedal pocket it will be found that the dog resists. Extension of the web is very painful. Frequently, particularly if the dog is of the small terrier type, it will be found impossible to examine the foot. The inflamed and swollen skin of the sole, and the very small feet, so restrict the movement that it is impossible to insert even the tip of the little finger into the pedal pocket. If the interdigital web can be palpated with one finger tip in the pedal pocket, and the thumb upon the upper web, the thickness and immobility will be evident. The normal interdigital web can be passed through the fingers like a piece of folded silk, so thin and delicate is it. The thickened web gives little information at this

XUM

stage. If a fold of the lower web can be pressed between the fingers, numerous indolent sebaceous glands will be evacuated and protrude minute cylinders of white or yellow sebum. This stage of acute eczema gradually subsides, and may proceed to the condition of chronic acne, following possibly the invasion of the already implicated sebaceous glands by the bacillus of acne, as is present in the very similar condition of acne vulgaris of the human.

In examining the feet of a patient suffering from acne of the foot, a time should be chosen when there is complete freedom from the interdigital lesions. The webs should be carefully palpated with the fingers. In the dog which has not long been subject to the condition, the web will be found to be still reasonably thin and elastic, but frequently small nodules of the size of a hemp seed may be distinguished in the lower web. If the dog now be turned upon his back, the pocket of the foot widely opened, and the sole closely examined, the offending gland forming the nodule will be seen. In the white dog the affected gland will have every appearance of the blackhead seen in the human form of acne. It is in fact a comedo or blackhead. In the black dog more difficulty is encountered, as the comedo is not easily seen. A lens may be used to search for the dilated mouth of the affected gland.

Several glands may be seen in various stages of impaction, many impalpable through the web, but all with the mouth plugged with the small dark body—the comedo. Some will be seen to project slightly above the surrounding skin, while others appear to be covered by the inflamed cuticle. The whole web may be inflamed, or one or two comedones perhaps show a zone of inflammation, according to their progress against infection.

To extrude the comedones or relieve the impacted glands, local pressure is required, either by means of a comedo extractor of a recognised type, or by the tips of the fingers. The latter is æsthetically poor, but practically more successful, and seeming to cause less discomfort to the dog. On pressure being applied around the rim of the gland, the black plug will emerge, followed by a cylinder of sebum of varying length until the gland is emptied. The sebum may be white or yellow in the white dog, or black, like axle-grease, in the dark-coloured dog. It is frequently possessed of an extremely objectionable odour, being very similar to the smell of a dog suffering from a chronic seborrhœa or follicular mange. Not infrequently the gland will deliver a small quantity of yellow fluid pus, demonstrating the presence of the pustular form of acne.

It is an interesting point that the large glands at the tip of the web between the toes, particularly the third and fourth toes, are frequently impacted, and contain a very large amount of sebum. Severe inflammatory symptoms are very rarely seen associated with these glands, despite their heavy impaction, the most severe symptoms being seen in the glands of the lower web. It is feasible to suggest that the former are free from the wear of the ground, and therefore from harm from that source, while the glands of the sole are open to continual danger of injury.

XUM

Lesions which cause lameness and which will proceed to the interdigital "cystic" stage, can occasionally be examined before rupturing into the space, and can usually be aborted. In these cases the examination of the web by palpation shows a large plaque-like nodule, painful on pressure, and evidently projecting boldly from the upper surface of the lower web into the interdigital space. It has a smooth upper surface and a broad base. This form of lesion implies a more acute inflammatory process than in the case of the comedones or the pustular form. It is probably abscess formation taking place, and may consist of one or probably more suppurating glands coalescing in the depth of the lower web. Examination of the lower web, even with a lens, gives little information of the affected follicle or follicles. The web is inflamed, but any further signs of suppuration in the depths of the skin are completely absent: it is the upper surface of the lower web that is showing all the classical signs of the rupture of an abscess. I have occasionally, when dissecting down to the lower web, happened upon a flattened, plaque-like sebaceous cyst, impacted with malodorous sebaceous material. A gland in this condition may, following injury to which the foot is subject, distend rapidly, and rupture with acute hæmorrhage into the interdigital space. Thomson and Miles, in their work upon Surgery, remark, when discussing sebaceous cysts: "As a result of injury the cyst may undergo sudden enlargement from hæmorrhage into its interior."

Twice have I had the good fortune to have been palpating a lesion at its moment of rupture into the space. On each occasion the dog was acutely lame, and upon palpation the acute, painful swelling could be felt high in the interdigital cleft, being about the size of a pea. During this examination the swelling was found to rupture under the finger like a tense, thin-walled bladder. The acute lameness was relieved at once, and a few minutes afterwards the interdigital space was soft and pappy from the subsequent hæmorrhage. These cases had all the sensation of the rupture of an acutely distended cyst.

As to the treatment of the acute acne lesions before their appearance as interdigital "cysts," it will be found that resting the foot by means of bandages or boots will frequently abort the condition. If the lesion has ruptured into the space, and become a "cyst," discretion must be used. If the pain be not too acute, the foot should be bandaged in the hope again of aborting rupture to the surface. In the event of the pressure becoming so great that rupture is imminent, or if the pain is extreme, the surface of the swelling must be cleansed, and the contents removed by means of a hypodermic needle. Opening the lesion widely is to be deprecated, as is curetting the interior. Both are unnecessary, and extremely painful. Of course, if persistent suppuration occurs, drainage must be supplied. Excessive surgical interference leads to the laying down of much fibrous tissue in the interdigital space, which restricts the movement of the digits to such an extent as to cripple an old case of this disease.

Having removed the acute lesion, the attention should be transferred to the sole of the foot. Comedones and pustules must be expressed at weekly intervals,

XUM

and between these times the foot must be washed daily, preferably with sulphur soap, and the feet protected from external irritation by leather or canvas boots. Exercise must be restricted, and taken if possible upon grass.

Vaccines and other methods of treatment I will not deal with. They have their successes and their failures, and impress upon the practitioner the stubbornness of this disease in reaction to any treatment, as do analogous diseases in the human.

Interdigital Cysts: A Clinical Observation.

By GEORGE DYKES, M.R.C.V.S.

Glasgow.

In a clinical study of thirty subjects suffering from the above condition for a period not exceeding twelve weeks from the appearance of the first cyst, it has been observed: (1) That from 60 per cent. of the total number of cysts dealt with, a distinguishable sebaceous plug—as derived from the sebaceous glands situated in the torus-metacarpalis, and/or metatarsalis, and the toruli digitalis interspaces—has been recovered from the fluid contents of freely incised cysts. In one instance the gland with contents intact was recovered. (2) In 20 per cent. of the total unformed sebaceous material flocculi was found. (3) In 5 per cent. a distended sebaceous gland was seen *in situ* projecting above the floor of the evacuated cavity. (4) In 15 per cent. no similarly distinguishable material was found. A study of the palmar surface invariably showed a more or less characteristic abnormality which varied in degree but not in kind; in all appearances closely resembling a more or less well-marked acne.

With a hearty co-operation of owners, for which I am grateful, a number of these subjects were placed under local treatment alone for a period. This treatment, which sought to confirm conclusions, took the form of an application of a ketone, followed by expression of the comedo or comedones from the aforementioned glands at weekly intervals. This has resulted in the non-appearance of interdigital cysts during a period at least three times that of their former occurrence in the respective subjects.

Summary.—The above observation, however inperfect it may be, suggests that the so-called " interdigital cyst " is but the occult evidence of a dilatation of the sebaceous follicles, a blocking of the ducts by comedones, and a dilatation of the blood vessels and exudation into what one may call the inter-cutem. In other words—acne.

Note.—While there was no pretension to an exact bacteriological examination of the fluid contents of these cysts, it is of interest to note that six of ten specimens drawn from these comparatively early cases showed no microscopical organisms in stained smears. What part, if any, organisms within the sebaceous glands play in the induction and persistence of this most distressing condition I must leave to minds more able than mine to answer.

XUM

Abstracts of Current Literature

A Case of Acetonæmia in the Cow. By M. DEMONT, D.V.M., Maiche. *Rec. de Méd. Vét.*, July, 1933.

A SEVEN-YEAR-OLD cow calved normally on February 11th, and was bought by her present owner on February 17th. The clerk who brought her remarked on the abnormal odour of her breath, but could not account for it. The owner, on the evening of her arrival, noticed the special odour of the breath, and of the milk when commencing milking. The cow, an excellent milker, gave 57 kilos. of milk at four milkings. The appetite, normal the first few days, became capricious, a slight falling away in condition was noticed, and a progressive diminution of lacteal secretion; at the same time the cow was very much out of breath. We examined the animal on March 6th; the special and characteristic odour of the expired air was quite evident on entering the shippon. The temperature was 101.2, respirations 41, but auscultation revealed neither sounds nor cardiac murmurs, although heart beats were accelerated. The conjunctivæ were normal. Yawning was frequent. Rumination irregular, fæces normal. The owner considered she had calved and cleaned herself, and vaginal exploration revealed whitish muco-purulent mucus as in fresh-calved cows.

We recommended sulphate of soda purgation and counter irritation with mustard to relieve the breathing. Then after taking away 20 c.c. of blood, we gave an intravenous injection of 40 grammes of calcium gluconate in solution. The blood obtained coagulated a quarter of an hour later, and revealed a beautiful red vermilion colour, remarkable for venous blood. Temperature in evening was 101.4.

March 7th, no improvement, milk dropped to 14 litres, no purgation, temperature 102.6 morning, 103.8 evening. The excrements were mucus-coated. The short respirations continued. We prescribed 300 grammes of bicarbonate of soda in warm milk. Lactation continued at same level March 8th, temperature fell to 101; breathing more normal, lacteal secretion increasing. March 28th, lactation up to 5¼ gallons. Breathing still short; milk and air (expired), no odour. The owner sold the cow in good condition.

This observation is recorded to show the digestive origin of this case of acetonæmia following a week after a normal calving in a cow in good condition, and rather fat. It shows the uselessness of intravenous injection of calcium gluconate, and contradicts the theory of hypocalcæmia as a sole cause of acetonæmia. This malady has been known for a long time by the name of post-partum dyspepsia. These digestive disturbances appear at calving (Janssen, 1908) in very good milkers in a state of *embonpoint*. Sjollema and van den Zande consider acetonæmia as an auto-intoxication of digestive origin with hypoglycæmia, and used with success injections of glucosed serum.

XUM

Vaccination of Dogs by the Laidlaw-Dunkin Method (Trans. title). By AXEL THOMSEN. *Maanedsskrift for Dyrlæger*, Vol. 45, No. 4, pp. 81–90. 1933.

IN this article Professor Axel Thomsen, of the State Serum Laboratory, Copenhagen, gives an account of the use of distemper vaccine and virus in Denmark. The laboratory arranged to obtain supplies of vaccine and virus from the Wellcome Physiological Research Laboratories, England, and distributed the products to veterinary surgeons in Denmark. Vaccine was sent from England by ordinary post, but virus travelled by air mail, and was kept in the cold room in Copenhagen, and distributed as required. Stocks were renewed frequently. Because of the short " life " of virus, instructions were issued to the Danish veterinary surgeons that it must be used by them on the day of receipt.

The article refers to 876 dogs treated during 1931–32 by 174 veterinary surgeons. Almost all were puppies twelve weeks of age and over. Reports of 784 of these dogs were received in September, 1932, and were generally favourable. Briefly, the following are the main points in the report : During, or immediately following, the immunisation process, 35 dogs showed symptoms resembling distemper ; in many, however, proper precautions were not observed. Of these, 21 were affected following the injection of vaccine. Two were already infected with distemper when injected, and both developed nervous symptoms—one was destroyed, and the other recovered after some months ; five developed distemper within three days of the injection of vaccine, one died ; fourteen developed distemper within two weeks of the injection of vaccine, two died. It is evident that these 21 cases were either suffering from distemper or were incubating the disease when injected with vaccine, or were exposed to infection before immunity from the vaccine had developed. The remaining 14 of the 35 dogs which became ill developed symptoms soon after both vaccine and virus had been injected. Two became ill within two days, and one within seven days of the injection of virus. The remaining 12 dogs became ill later, and one died. Of the 14 cases, nine were regarded as mild attacks, and doubt is expressed as to the nature of the affection in the other five dogs. The author regards this result as highly satisfactory, since 95 per cent. of the dogs remained free from distemper, and of the 5 per cent. which became infected, a considerable number had received vaccine only.

Attention is drawn to the necessity of protecting dogs against the risk of infection before and during the process of immunisation. The author considers that dogs are infectious after the injection of virus, and states that Slagsvold has proved this point experimentally.*

Regarding the duration of immunity, there is evidence from reports received on 246 dogs that all, with the possible exception of one, successfully withstood exposure to natural infection. Further, it is reported that many veterinary

* We understand that this is not the view held by English investigators and veterinary surgeons.—ED.

XUM

surgeons have vaccinated their own dogs, which have since been frequently exposed to infection without developing symptoms of infection. In connection with complications arising after immunisation, an account is given of the experiences of some veterinary surgeons. Nothing of a serious nature occurred. Eleven report some malaise following the injection of virus ; seven noted swellings and occasional abscess formation following the injection of vaccine ; these healed slowly and may have been due to faulty technique or to the action of the formalin in the vaccine. The author suggests that it is well to clip the hair, dry shave and paint the skin with iodine before making an injection. He also thinks that it might be better to divide up the dose of vaccine and inject it in several places. Urticaria, rash or eczema was reported by five veterinarians, and four had seen anaphylactic shock. Tremors in the hind quarters were noted in 45 dogs about fourteen days after vaccine was injected, and one dog showed some keratitis ; all these disappeared within three weeks. A rather unique case is reported. A healthy dog, three and a-half months old, received 5 c.c. vaccine, and within a few minutes became very ill with severe dyspnœa, followed by a blood-stained discharge from the nose and mouth. Some improvement occurred, but the dog died next morning from a double pneumonia. The author thinks that these symptoms might possibly have been caused by the vaccine being introduced intravenously. He could not, however, reproduce the condition experimentally, nor had he met with a similar case in the 1,200 other dogs injected. He learned from the Beckenham Laboratories that there was no record of such an occurrence in England. A reference to the use of hyper-immune serum indicates that its efficacy as a prophylactic is high, but that its high cost limits its use.

Summary.

In 1931–32, 876 dogs were vaccinated by 174 veterinary surgeons. In the autumn of 1932, reports of 784 dogs were available ; 95 per cent. were apparently immune, and had escaped distemper. About 2 per cent. showed symptoms of distemper subsequent to the completion of the course of immunisation—the symptoms were mild, one dog only died. The results may be considered excellent. The author considers that immunity against distemper is one of the most beautiful achievements of modern veterinary science.

Half of Counties in U.S. Tuberculosis Free.—*North American Veterinarian*, September, 1933.

More than half of the counties in the United States are now practically free of bovine tuberculosis, according to a map just issued by the U.S. Department of Agriculture. Various degrees of shading show the status, on July 1st, 1933, of eradication work in every county of the United States. This work, begun in 1917 by the Department in co-operation with the various States, has reduced the infection to a minimum in 1,626 counties, or 53 per cent. of the total in the United States. Eleven States have been officially designated as modified accredited areas,

XUM

signifying that tuberculosis among cattle has been reduced to 0.5 per cent. or less of the cattle population. These States are North Carolina, Maine, Michigan, Indiana, Wisconsin, Ohio, Idaho, North Dakota, Nevada, New Hampshire and Utah. The last two states qualified for accreditation on July 1st, 1933. Several others, it is expected, will qualify for similar recognition by the end of the year.

AND SO AT LAST IT CAME TO THIS.

By FRED. W. LANGE, D.V.M., Salem, Oregon. *North American Veterinarian*, September, 1933.

THE depression was fifteen years old when final disaster overtook the *Veterinarius cussibus* (nearly extinct). His left ear was calloused, and his left arm withered from using the telephone dispensing free advice. His sight had diminished to a point where he could see only when behind two headlights. The State was vaccinating all the hogs, the Federal Government was bleeding and testing all cattle, the County Agent was doing the work of a veterinarian. So he finally went berserk. In common mercy the Humane Society took him out in the woods, said a few kind words to him and knocked him on the head. His tortured soul, travelling upward to its reward, suddenly found him where the pavement was hot. The Prince of Fallen Angels sat before him grinning. Then came the lurid details of his existence below. Four thousand animals testified that in operating upon them he used no anæsthesia, and his knife was dull. Men swore that he attended no meetings, that he patronised wildcat drug-houses, and cut prices. He begged for another chance, and in consideration of what he had gone through, he was sent back to earth. In the winter he works for dairymen, thawing cows' udders with a blow torch, and in the summer he clips warts from cows' teats and sells them to frog farms.

Reviews

Veterinary Obstetrics and Zootechnics.—By MAJOR HOWARD N. BEEMAN, D.V.M. Pp. 124. London: Baillière, Tindall & Cox. Price 12*s.* 6*d.*

THIS little book is stated by the author to be a compilation culled from various sources in an endeavour to place before the veterinary practitioner as briefly as possible, and in handy, readable, form, the salient points from standard text-books on the subject of veterinary obstetrics and zootechnics generally. The opening chapters give a detailed description of the anatomy and physiology of the female generative organs and the fœtal membranes, and this is followed by a discussion of the problems incidental to each period of the reproductive cycle. The descriptive chapters on foaling time and the hygiene and diseases of the foal are palpably written by a man who has had considerable practical experience of these subjects. The details of the breeding season are entered into, and the normal aspects are described; but the chapter

which will interest the veterinarian most is the one on the Diagnosis and Pathology of Sterility. The experience of the author in this subject has evidently been extensive, and the chapter is carefully summarised, in so far as the opinions of various authorities can be abstracted and embodied, by Major Beeman. The book is a handy compendium and easily readable, and can be recommended as a useful addition to the practitioner's library.

Organic Chemistry for Medical Students. By GEORGE BARGER. Gurney & Jackson. Pp. 249. 1932. Price 12*s.* 6*d.* net.

THE author of this text-book assumes that the chief reason for including organic chemistry in the medical curriculum is to provide a basis for biochemistry or chemical physiology and pathology, and expresses the view that much that is included in the preliminary training of organic chemists is quite unnecessary for medical students. Few teachers in medical or veterinary schools would disagree with these principles, but probably there would be much divergence of opinion concerning how much of such preliminary training in organic chemistry should be omitted in a course for students of medicine. There appears to be a tendency at the present time to spend comparatively little time on the fundamental elementary principles of chemistry, and to expect the medical or veterinary student to proceed to the study of such bodies as glucosides, polypeptides and heterocyclic compounds equipped with an inadequate knowledge of the elementary principles on which the science is based. This tendency is apparent in the book under review; much of the space that might have been allotted to the elementary portions of the subject has been sacrificed to the more advanced sections. The details required by the organic chemist and not by the medical student apparently extend even to some forms of apparatus: thus the inlet and outlet tubes wisely provided by Liebig in his condenser have been abolished in fig. 4, page 20. This book should be available to students in all our medical and veterinary schools, since those subjects of biological and pharmacological interest are written with the usual clarity of Professor Barger when presenting the results of investigations in those fields which he has enriched by his own labours. G.W.C.

Correspondence

DOG FOODS AND RESEARCH.

To the Editor of THE VETERINARY JOURNAL.

SIR,—The first question in Mr. Blount's letter in your last issue arises from my careless use of the term " aerated " in its technical or factory sense. The " aerating " agent is not air, but carbon dioxide, and this actually protects the vitamin concentrates from atmospheric oxidation. Further, the cooking and baking temperatures, and the times of exposure to these temperatures are such that the vitamin destruction is small and of known amount. No special vitamin C supplement is added to Spillers dog foods because this factor is outstandingly unstable and because all the evidence goes to show that the dog synthesises this factor from the carbohydrates he receives. One of the most striking demonstrations of this was the work of Mr. J. R. M. Innes, M.R.C.V.S., at the Cambridge Institute of Animal Pathology in 1931. Puppies fed for five months on a diet which was scorbutic for guinea-pigs were indistinguishable

XUM

from the control dogs receiving a vitamin C supplement. Yet the livers of the two sets were equally potent as sources of vitamin C.

The answer to the second question is that Spillers Winalot after baking contains not less than eighty International units of vitamin D per 100 grams. This amount is adequate for satisfactory nutrition, and the possibility of hypervitaminosis D is avoided. As regards the vitamin B supplements which Spillers have added to their food for many years, I can only say that feeding tests, both with dogs and other test animals, have never given results indicative of either vitamin imbalance or hypervitaminosis B. In this connection it should be noted that in our manufacturing processes the toxic elements found in ordinary wheat germ are eliminated without loss of vitamin potency. Finally, it has been established that a lack of the vitamin B complex is frequently connected with lack of appetite or "shy feeding." Although Mr Blount's specific questions all relate to the vitamin content of these dog foods, it is pleasing to observe that in his first paragraph he stresses the fundamental necessity of wholesome balanced basic nutrients; without these, vitamin supplements are useless.

Yours faithfully,

ALBERT GREEN.

HORSE SKULLS AT BUNGAY.

SIR,—Whilst at Bungay recently I made inquiries regarding the collection of horses' skulls which were found under the floor boards of an old house in Earsham Street, and two explanations are offered: (1) That they were placed there to deaden sound. (2) That they are in the nature of a "sacrifice." In olden days, especially in this part of England, it was the custom to offer a victim when a bridge or other building was built, the victim being placed under one of the bridge supports or under the foundations.

Yours faithfully,

DONALD TUTT, F.R.C.V.S.

Personal

COLONIAL SERVICES.

Capt. S. H. Whitworth, Dr. Med. Vet. (Zurich), B.V.Sc. (Melbourne), M.R.C.V.S., late Veterinary Pathologist, Gold Coast, to be Director of Veterinary Research and Veterinary Adviser, Malaya.

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